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Water Plant Optimization Study

TORONTO R.C. HARRIS WATER TREATMENT PLANT

December 1990

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Water Plant Optimization Study

Toronto-R.C. Harris Water Treatment Plant

Project No. 7-2014

December 1990

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WATER PLANT OPTIMIZATION STUDY
R.C. HARRIS WATER TREATMENT PLANT

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The purpose of the Water Plant Optimization study (WPOS) is to document and review the recent conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on the removal of particulate materials and the disinfection processes.

In striving for excellence in water treatment, it is important to examine all possible approaches, but first, optimum use should be made of the processes already in place.

This optimization study is a beginning and not an end to itself; it is the start of an ongoing documentation of the operation of the plant. It is recommended that this document be updated on an annual basis.

The plant is presently installing a computerized operating system which includes a process control system for the plant and on-line status reporting. This system should improve the data collection and process control of the plant.

The R.C. Harris Water Treatment Plant, by way of Metro Toronto staff, have made considerable strides towards optimization. This study has identified some areas of further action and study.

In an effort to optimize particulate removal and disinfection at the R.C. Harris Plant, the following are suggested:

SUMMARY OF FINDINGS AND RECOMMENDATIONS (cont'd)

STUDIES

- Conduct laboratory and plant scale testing to evaluate the merits of flash mixing.
- Evaluate the merits of streaming current monitors.
- Conduct plant scale testing to evaluate the effect of lower filtration rates on filter effluent quality. The effects of coagulant aids, filter aids in the backwash, and ramping a filter at start-up should also be investigated.
- Determine an optimum backwash procedure.
- Investigate the transfer of chlorine into the water.
- Solicit a WPOS research study to investigate aluminum residual.

OTHER RECOMMENDATIONS

- Continue to identify areas of leakage and budget for needed rehabilitation and repairs.
- The Ministry of the Environment should develop a surrogate measurement for chlorinated by-products for use in water plants in Ontario.

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WATER PLANT OPTIMIZATION STUDY
R.C. HARRIS WATER TREATMENT PLANT

INTRODUCTION AND TERMS OF REFERENCE

The terms of reference for this report are included at the back of the report, following the appendices.

The terms of reference for the overall program have evolved during the period of this study. So as to make this report similar to later reports, we have included items which are requested in the newer terms of reference.

The R.C. Harris Water Treatment Plant draws water from Lake Ontario, which experiences slightly worse water quality during the winter/spring months (December-April) when the raw water turbidity increases. Overall, the operation of the R.C. Harris Plant is very good, and the plant consistently produces a treated water with a turbidity of much less than 1 FTU.

SECTION A
RAW WATER SOURCE

SECTION A
RAW WATER SOURCE

A.1 General Quality

The R.C. Harris Filtration Plant draws water from Lake Ontario. The raw water is generally good, with low turbidity, but on occasion the turbidity has reached 40 FTU. Occasionally, algae and coliform counts are high.

In the years 1983 to 1986, the raw water quality parameters varied as follows:

Turbidity (FTU)	0.3-40	(1)
Colour (HCU)	2-10	(2)
Temperature (°C)	1-23	(1)
pH	7.5-8.8	(1)
Hardness (mg/L as $CaCO_3$)	127-140	(2)
Alkalinity (mg/L as $CaCO_3$)	83-100	(2)
Aluminum (mg/L)	0.015-0.280	(1)
Iron (mg/L)	0.003-0.025	(2)
Manganese (mg/L)	0.001-0.002	(2)
Fecal Coliform (per 100 mL)	0*-12,000	(1)
Total Coliform (per 100 mL)	0*-37,000	(1)

Notes:

(1) Taken from log sheets at the R.C. Harris plant.
(2) Taken from the DWSP.
* Zero means minimum results have been obtained.

Historically, neither raw water quality nor plant output vary seasonally to any great extent. The latter is principally due to the seasonal operation of the Toronto Island Filtration Plant which supplements the output in the summer months.

A.1 General Quality (cont'd)

The consistency of the raw water quality at the R.C. Harris plant can be partially attributed to the length of the intake. Other plants on Lake Ontario with intakes of shorter length experience greater turbidity events, particularly during the spring, than does the R.C. Harris plant.

Detailed water quality data are included in Tables 2.0, 2.1 to 2.7, 5.0 and 5.1 in Appendix I of this report.

SECTION B
FLOW MEASUREMENT

SECTION B
FLOW MEASUREMENT

B.1 Raw

Raw water flow is measured by six venturi meters; two 762 mm meters have capacities of 270 ML/d each and four 1067 mm meters have capacities of 330 ML/d each. All venturi meters have either BIF or Simplex transmitters.

The summated raw water flow is displayed on the control panel. The flow through each venturi is recorded every hour on the daily record. Integrator readings are taken every hour, and the raw water flow is recorded daily. The flow from the six raw water venturi meters is summated by 15 second time pulse flow signals. The instrumentation technician calibrates the summated pulse signal once a month.

B.2 Filtered

The filtered water flow is measured by two concrete, rectangular venturi meters, one in each filtered water header. Each venturi has a 2.7 m x 2.1 m inlet, and 2.7 m x 0.38 m throat. The capacity of each venturi is 639 ML/d.

The flow from each filtered water venturi meter is recorded continuously on a chart. Integrator readings are taken every 24 hours, and the filtered water flow for the day is recorded.

B.3 Treated

Plant output is measured by seven venturi meters; four high lift discharge venturi meters, one Eglinton reservoir venturi, one Scarborough reservoir venturi, and one John St. tunnel venturi. All meters have either BIF or Simplex transmitters. The sizes and capacities of the seven venturi meters are listed below.

B.3 Treated (cont'd)

Meter	No.	Size (mm)	Capacity (ML/d)	Diff. Pressure (mm H_2O)
High Lift Discharge	2	762 x 509.3	147 each	529.00
High Lift Discharge	2	762 x 509.3	216 each	1135.77
Eglinton Reservoir	1	1219 x 800.1	363	535.49
Scarborough Reservoir	1	1067 x 762.0	198	1497.29
John St. Tunnel	1	2133 x 1066.8	726	768.17

The treated water flow leaving the plant is totalized continuously in the control room. The treated flow through each venturi is recorded every hour on the daily record. Integrator readings are taken every hour to check the ammonia dosage, and the plant output is recorded daily. The instrumentation technician calibrates the summated pulse signal once a month.

B.4 Backwash

Three backwash pumps discharge into a common header which is metered by a 600 mm venturi meter. The capacity of this meter is 112 ML/d at 2972 mm W.C. (117.08").

Both wash water tanks are filled by the backwash pumps prior to backwashing a filter. Backwashing of a filter is accomplished by emptying both wash water tanks. The three backwash pumps are operated simultaneously to supplement the wash water flow.

Flow metering from the tank to the filter is by four Hersey Products Inc. "Ramapo" Model V-30-PIM01 flow meters. The two south meters have capacities of 15 to 150 ML/d, and the two north meters have capacities of 10 - 100 ML/d. Two flow meters are required to measure the flow into any filter.

B.5 Filters

All forty filters at the R.C. Harris plant have separate venturi flow meters. These flow meters have a capacity of 43.2 ML/d each. The flow through each filter is recorded hourly. These flow rates are used for flow control only, the flow through the two filtered water venturi meters is used for chemical flow pacing.

At the present time, the filter rates are decided by the Filtration Plant Operator (FPO), and are set by a Filter Operator (PO4) at the control panel. All of the filters on either the East or West side are set at the same rate. When the computer system becomes operational, the automatic mode will set the filter rates based on the settled water level. The valves to a filter must be manually operated to take a filter out of service.

B.6 Validity

All venturi meters are calibrated once every three months using manometer and electronic timers. Transmitters are upgraded periodically as necessary. The metering system in the plant has a good history of reliability with no obvious discrepancies present during the 1983 - 1986 period.

The flow data in Table 1.0 of Appendix A shows a consistent and systematic set of information. The per capita flow data could not be determined since R.C. Harris does not supply water to the same area all of the time.

SECTION C
PROCESS COMPONENTS

SECTION C
PROCESS COMPONENTS

C.1 General

The following drawings are included in Appendix F:

(a) Site Plan
(b) Plant Flow Diagram
(c) Block Schematic

This section includes detailed information on Design Data and Chemical Systems.

This section also contains a series of photographs to illustrate the major plant components and chemical feed systems.

C.2 Design Data

(a) Plant Capacity

The original plant was constructed by the City of Toronto and commenced operation in November, 1941. It included twenty rapid sand filters and was rated at 455 ML/d.

The plant was enlarged to 910 ML/d in 1958 with the construction of a second intake, doubling of flocculation, sedimentation and filtration areas, and installation of associated piping and pumping equipment. The plant can operate up to 1000 ML/d.

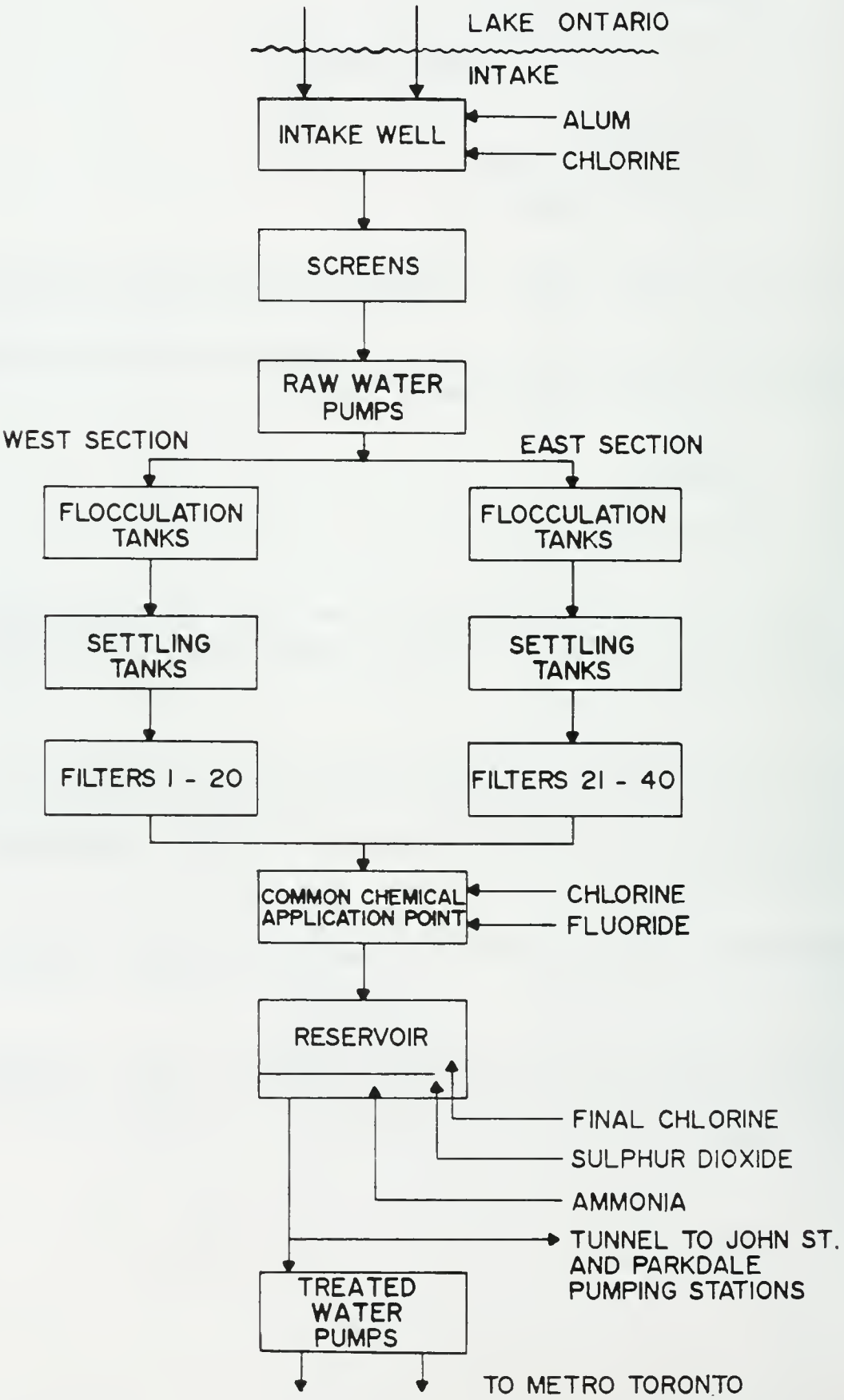
The West section contains Filters 1-20, and the East Section contains Filters 21-40.

The nominal rated capacity of the plant is 1000 ML/d, with a present average daily flow of 650 ML/d. All of the operating data presented herein are based on flows of 650 and 1000 ML/d.

FIGURE I

R.C. HARRIS WATER TREATMENT PLANT

PROCESS AND PIPING SCHEMATIC



(a) Plant Capacity (cont'd)

Both raw water headers feed all mixing chambers and settling tanks, therefore, we have assumed that the total flow splits evenly between the East and West Sections.

(b) Intake

The intake system at the R.C. Harris plant consists of two 2450 mm diameter concrete lined steel intake pipes, each approximately 1300 metres long. Both intake pipes discharge into a 3050 mm diameter intake tunnel in rock below the lakebed. This tunnel is 1000 metres long and terminates at the intake well. The original intake was constructed in 1941. The second intake pipe was added during the plant expansion in 1958.

(c) Intake well

The intake tunnel terminates in a concrete intake well with dimensions of 13.0 m x 4.9 m x 9.7 m deep.

Chlorine and alum are added here.

(d) Screening

There are eight travelling water screens, each having a separate screen chamber. Each screen is 1.8 metres wide and 10 metres deep. The mesh material is 3 mm diameter brass wire with 13 mm x 13 mm openings. The screens are manually cleaned each day except in the winter (December to March). Since less debris is deposited at this time, the screens may be cleaned once every 3 to 4 days.

(e) Raw Water Pumping

There are two concrete low lift suction chambers; each measures 13.0 m x 3.0 m x 9.7 m deep. There are six low lift pumps.

(e) Raw Water Pumping (cont'd)

NO.	TYPE	CAPACITY (ML/d)	POWER (kW)
1	Electric	115.0	390
1	Electric	180.0	615
1	Electric	230.0	765
3	Electric	275.0 ea.	970(2), 1045(1)
TOTAL INSTALLED		1350.0	
FIRM CAPACITY		1075.0	

(f) Flash Mixing

There is no flash mixing at R.C. Harris.

(g) Flocculation

All flocculation tanks are hydraulic spiral over and under flow, and are made of concrete.

All flocculation at the R.C. Harris plant is three stage flocculation. Each sedimentation tank is fed by a bank of twelve flocculation tanks, four sets of three tanks in series. The width and depth of all tanks are 6.4 metres and 7.3 metres respectively. The length of the tanks vary from 5.97 metres to 6.53 metres.

The volumes and detention times for the individual floc tanks are tabulated below.

(g) Flocculation (cont'd)

Flocculation Tanks 5.97 m x 6.40 m x 7.31 m:

	Volume (m^3)	Detention Time at 650 ML/d (min.)	Detention Time at 1000 ML/d (min.)
Cell 1	279	14.8	9.65
Cell 2	279	14.8	9.65
Cell 3	279	14.8	9.65
TOTAL	837	44.4	28.95

Two of the twenty four (24) sets of flocculation tanks are this size.

Flocculation Tanks 6.07 m x 6.40 m x 7.31 m:

	Volume (m^3)	Detention Time at 650 ML/d (min.)	Detention Time at 1000 ML/d (min.)
Cell 1	284	15.1	9.8
Cell 2	284	15.1	9.8
Cell 3	284	15.1	9.8
TOTAL	852	45.3	29.4

Six of the twenty four (24) sets of flocculaton tanks are this size.

(g) Flocculation (cont'd)

Flocculation Tanks 6.43 m x 6.40 m x 7.31 m:

	Volume (m^3)	Detention Time at 650 ML/d (min.)	Detention Time at 1000 ML/d (min.)
Cell 1	300	16.0	10.4
Cell 2	300	16.0	10.4
Cell 3	300	16.0	10.4
TOTAL	900	48.0	31.2

Six of the twenty four (24) sets of flocculation tanks are this size.

Flocculation Tanks 6.53 m x 6.40 m x 7.31 m:

	Volume (m^3)	Detention Time at 650 ML/d (min.)	Detention Time at 1000 ML/d (min.)
Cell 1	305	16.2	10.6
Cell 2	305	16.2	10.6
Cell 3	305	16.2	10.6
TOTAL	915	48.6	31.8

Ten of the twenty four (24) sets of flocculation tanks are this size.

(g) Flocculation (cont'd)

The mixing velocity gradients in the flocculation tanks have been estimated based on a mixing energy input equivalent to the loss of momentum of the water entering the tanks. This is a conservative estimate of the total mixing, since other energy losses occur during passage of the water from one tank to another. This additional mixing energy could result in G values which are as much as 25 percent higher. The actual energy loss can be obtained from precise hydraulic tests.

Useful flocculation velocity gradients range from 100 to <10 sec $^{-1}$. A "tapered" or stepped series should be used; the highest mixing is provided initially, progressing through a series of cells of decreasing mixing levels. Additionally, the dimensionless parameter, Gt, which is the product of velocity gradient and the duration of mixing, is a most useful parameter which usually must have values within the range of 10^4 to 10^5.

Estimated Velocity Gradient at 10°C:

Floc Tank Vol.= 279 m^3	54 ML/d	83 ML/d
Cell 1	G = 8.8 s^{-1}	G = 16.6 s^{-1}
Cell 2	G = 6.2 s^{-1}	G = 11.9 s^{-1}
Cell 3	G = 8.8 s^{-1}	G = 16.6 s^{-1}
Overall	Gt = 2.1 x 10^4	Gt = 2.6 x 10^4

Floc Tank Vol.= 284 m^3	162.5 ML/d	250 ML/d
Cell 1	G = 8.7 s^{-1}	G = 16.5 s^{-1}
Cell 2	G = 6.2 s^{-1}	G = 11.8 s^{-1}
Cell 3	G = 8.7 s^{-1}	G = 16.5 s^{-1}
Overall	Gt = 2.1 x 10^4	Gt = 2.6 x 10^4

Floc Tank Vol.= 300 m^3	162.5 ML/d	250 ML/d
Cell 1	G = 8.5 s^{-1}	G = 16.0 s^{-1}
Cell 2	G = 6.0 s^{-1}	G = 11.5 s^{-1}
Cell 3	G = 8.5 s^{-1}	G = 16.0 s^{-1}
Overall	Gt = 2.2 x 10^4	Gt = 2.7 x 10^4

(g) Flocculation (cont'd)

Floc Tank Vol.= 305 m^3	271 ML/d	417 ML/d
Cell 1	G = 8.4 s^{-1}	G = 15.9 s^{-1}
Cell 2	G = 6.0 s^{-1}	G = 11.4 s^{-1}
Cell 3	G = 8.4 s^{-1}	G = 15.9 s^{-1}
Overall	Gt = 2.2 x 10^4	Gt = 2.7 x 10^4

(h) Settling Tanks

The settling tanks are horizontal cross-flow and are constructed of concrete.

There are a total of six settling tanks in the plant, three in the East Section and three in the West Section. All tanks are the same length, 91.2 metres, the same depth, 7.3 metres, but vary in width from 25.9 metres to 27.4 metres.

Settling Tank Nos. 3, 6	Dimensions:	91.2m x 27.1m x 7.3m each
	Total Volume:	36,084 m^3
	Total Surface Area:	4,943 m^2
Settling Tank Nos. 2, 5	Dimensions:	91.2m x 27.4m x 7.3m each
	Total Volume:	36,484 m^3
	Total Surface Area:	4,998 m^2
Settling Tank Nos. 1, 4	Dimensions:	91.2m x 25.9m x 7.3m each
	Total Volume:	34,486 m^3
	Total Surface Area:	4,724 m^2

For settling tank nos. 3 and 6, assuming an even split of flow, the theoretical detention time at 1000 and 650 ML/d flows are 156 and 240 minutes, respectively. For similar flow conditions, the overflow rates are 2.8 and 1.8 m/h, respectively.

(h) Settling Tanks (cont'd)

For settling tank nos. 2 and 5, assuming an even split of flow, the theoretical detention time at 1000 and 650 ML/d flows are 158 and 242 minutes, respectively. For similar flow conditions, the overflow rates are 2.8 and 1.8 m/h, respectively.

For settling tank nos. 1 and 4, assuming an even split of flow, the theoretical detention time at 1000 and 650 ML/d flows are 149 and 229 minutes, respectively. For similar flow conditions, the overflow rates are 2.9 and 1.9 m/h, respectively.

(i) Filters

The R.C. Harris plant has a total of forty filters, all of which have been converted from sand to dual media, i.e. sand and anthracite. All forty filters are 9.0m x 20.7m, which provides a total filtration area of 7452 m^2.

All filter boxes are constructed of concrete. All filters have surface agitators and constant rate controllers. Presently, the filter rates are manually adjusted each hour, or as needed, by a plant operator (PO4). When the computer system is operational, the filter rates will be adjusted automatically.

(i) Filters (cont'd)

FILTERS 1-20, WEST SIDE (1941)

	W (m)	L (m)	(1) D (m)	SURFACE AREA (m^2)
Individual	9.0	20.7	2.69	186.3
Total				3726

NOTES:

(1) D (m) is depth of water in the filter box in metres.

(2) All filters have 100 mm diameter cast iron lateral underdrains.

(3) The filter media has a total depth of 101.6 cm and is broken down as follows (as per specifications):

	PARTICLE SIZE (mm)	DEPTH (m)
Anthracite	0.95 - 1.05	0.254
Sand	0.50 - 0.55	0.254
Gravel	1.19 - 2.38	0.051
Gravel	2.38 - 4.76	0.076
Gravel	4.76 - 12.7	0.076
Gravel	12.7 - 25.4	0.102
Gravel	25.4 - 76.2	0.203

(i) Filters (cont'd)

FILTERS 21-40, EAST SIDE (1958)

	W (m)	L (m)	(1) D (m)	SURFACE AREA (m^2)
Individual	9.0	20.7	2.53	186.3
Total				3726

NOTES:

(1) D (m) is depth of water in the filter box in metres.

(2) All filters have 100 mm diameter cast iron lateral underdrains.

(3) The filter media has a total depth of 116.8 cm and is broken down as follows (as per specifications):

	PARTICLE SIZE (mm)	DEPTH (m)
Anthracite	0.95 - 1.05	0.305
Sand	0.50 - 0.55	0.305
Gravel	1.19 - 2.38	0.051
Gravel	2.38 - 4.76	0.076
Gravel	4.76 - 12.7	0.076
Gravel	12.7 - 25.4	0.076
Gravel	25.4 - 76.2	0.279

(i) Filters (cont'd)

Raw Water Turbidity Range (FTU)	0.63-3.9 (readings taken once every 2 hours). These figures obtained by operators taking grab samples from sample taps in operator's lab and measuring turbidity with a Hach 2100A.
Effluent Turbidity Range (FTU)	0.12-0.27 (readings taken once every 2 hours). These figures obtained by operators taking grab samples from sample taps in operator's lab and measuring turbidity with a Hach 2100A.
Length of Run	72 hours; this is a figure presently used year round at the R.C. Harris plant to terminate filter runs. There are times when the filter runs may be reduced to 24 hours or less, due to headloss accumulations of 1.5 m.
Headloss (Clean Bed/Dirty Bed)	0.4 m/1.5 m
Flow Rate	5.6 and 3.6 m/h at 1000 and 650 ML/d, respectively.
Backwash Flow Rate *	Low: 20 m/h High: 35 m/h
Water Filtered/Cycle/Unit Area	400 m^3/m^2/cycle
Backwash Water/Wash *	4 m^3/m^2

*Based on investigations conducted by Metro staff.

(j) Reservoir

The reservoir is constructed of concrete, has dimensions of 237.3 m long x 48.3 m wide x 4.1 to 6.4 m deep. There are many support columns within the reservoir, and, therefore, the total usable capacity of the reservoir is approximately 55 ML.

(k) Backwash Water Tanks

There are two wash water tanks, both constructed of concrete, which have a combined capacity of 0.665 ML. These tanks are filled by the three backwash pumps shortly before a backwash. Originally, these tanks were to be kept full at all times, but due to leakage through the valves, the tanks are not filled until required.

(k) Backwash Water Tanks (cont'd)

The combined volume of water contained in both tanks is approximately the volume required to backwash one filter. One filter is backwashed at a time, and usually several are washed consecutively. Due to leakage through valves, the three backwash pumps operate simultaneously as the tanks are emptied.

When the computer system becomes operational, only two backwash pumps will be used for the filling of the wash water tanks, and during the backwashing of a filter.

(l) Backwash Water Pumps

NO.	TYPE	CAPACITY (ML/d)	POWER (kW)	DISCHARGE HEAD (m)	PUMP NO.
1	Electric	22.7	55	16.5	7
1	Electric	34.1	75	16.5	6
1	Electric	45.4	110	16.5	5

(m) Treated Water Pumping

The pumping station at the R.C. Harris filtration plant contains nine treated water pumps and has two 2134 mm diameter cast iron suction headers. All pumps are horizontal split case, double suction. Three of the treated water pumps feed the Scarborough reservoir. These pumps were added at a later date, and are located at the east end of the pumping station, in a separate area.

NO.	TYPE	CAPACITY (ML/d)	POWER (kW)	DISCHARGE HEAD (m)
3	Electric	90.8	745(2), 970(1)	61.0
2	Electric	95.3	745	82.3
4	Electric	113.5	1400	91.5
TOTAL INSTALLED		917		
FIRM CAPACITY		803.5		

(m) Treated Water Pumping (cont'd)

The firm capacity assumes the loss of the largest pumping unit.

The R.C. Harris plant gravity feeds the John Street Pumping Station and the Parkdale Pumping Station. The associated high lift pumps for the water supplied by R.C. Harris are listed below:

JOHN STREET PUMPING STATION

NO.	TYPE	CAPACITY (ML/d)	POWER (KW)	DISCHARGE HEAD (m)
8	Electric	472.2	1120	73.2
1	Electric	45.4	520	73.2
TOTAL INSTALLED		3823		
FIRM CAPACITY		3350.8		

PARKDALE PUMPING STATION

NO.	TYPE	CAPACITY (ML/d)	POWER (KW)	DISCHARGE HEAD (m)
2	Electric	317.8	745	85.4
2	Electric	136.2	745	81.7
TOTAL INSTALLED		454		
FIRM CAPACITY		385.9		

(n) Backwash Treatment

Presently, the plant has no waste water treatment facilities. The backwash water is discharged directly into Lake Ontario, through a drain pipe extending approximately 25 m from the shoreline.

(o) Settling Tank Waste

The settling tank sludge is also discharged directly into Lake Ontario, through a drain pipe extending approximately 25 m from the shoreline. The tanks are cleaned once a year.

C.3 Chemical Systems

(a) Disinfection

Chlorine is stored as a liquid in 0.9 tonne containers.

Application points:

Pre- Intake well (prior to travelling water screens)
Post- Reservoir inlet (at common point)
Final - Entrance to reservoir output channel

Equipment :

2 - Wallace and Tiernan Evaporators (post dedicated)
3 - Wallace and Tiernan Evaporators (pre dedicated)
4 - 3500 kg/d Fisher and Porter Chlorinators
1 - 1400 kg/d Fisher and Porter Chlorinator
2 - scales for three 0.9 tonne cylinders (post dedicated)
1 - scale for two 0.9 tonne cylinders (standby dedicated)
1 - scale for two 0.9 tonne cylinders (pre dedicated)

Evaporators are dedicated to either pre or post. Chlorinators are not dedicated and can be used for either pre or post chlorination.

The combined total feed rate from the chlorinators could be 15,400 Kg/d, for a total dosage of 15.4 to 23.7 mg/L for 1000 and 650 ML/d flow rates, respectively.

(b) Coagulation

Liquid alum is stored in two PVC-lined storage tanks. The capacity of each tank is 90,500 L.

Presently, alum is fed directly by gravity through a rotameter from the storage tanks. The alum dosage is manually adjusted or remotely controlled.

The present application point is the intake well. In the near future, alum will be applied through a diffusor into both raw water headers located on the low lift discharge following the venturi metres.

Three alum pumps have been installed to enable the alum dosage to be monitored and controlled by the supervisory control system currently being installed. These pumps are Pulsa diaphragm metering pumps, Model No. 7660, each having a capacity of 11.8 L/min. The pumps have a manual stroke length adjustment and the speed is flow paced from the raw water flow. The maximum dosages available with two metering pumps operating is 22 and 34 mg/L for 1000 and 650 ML/d, respectively.

(c) Fluoridation

Fluoride is added in the form of hydrofluosilicic acid. The acid is stored in four rubber-lined steel storage tanks; two have usable capacities of 22,500 L each, and two have usable capacities of 20,000 L each.

Fluoride is fed from two day tanks, each having a capacity of 850 kg or approximately 695 L, based on a solution specific gravity of 1.224. The fluoride is metered by two Wallace and Tiernan Model 44-216 metering pumps with maximum capacities of 4.73 L/min each. The pumps have a manual stroke length adjustment for dosage and the speed is flow paced from the filtered water flow. The maximum dosage capacities available with two metering pumps operating are 3.3 and 5.0 mg/L for 1000 and 650 ML/d, respectively, however, normally only one fluoride pump is operated.

The application point is at the entrance to the reservoir.

(d) Dechlorination

Sulphur dioxide is stored as a liquid in 0.9 tonne containers.

The application point is at the entrance to the reservoir output channel.

Equipment:

3 - Wallace and Tiernan Evaporators, Model No. 24719
1 - 3500 kg/d sulphonator
1 - 1920 kg/d sulphonator
1 - 1300 kg/d sulphonator
2 - scales for three (3) 0.9 tonne cylinders each

The combined total feed rate from the sulphonators could be 6720 Kg/day, for a total dosage of 6.7 to 10.3 mg/L for 1000 and 650 ML/d flow rates, respectively.

(e) Chloramination

Aqua-ammonia is stored as a liquid in four 8500 L storage tanks which feed two day tanks. The day tanks are on scales, and each has a maximum capacity of 650 kg or approximately 730 L, based on a solution specific gravity of 0.89.

There are two Pulsa Model No. 7120 metering pumps; one duty and one standby. Each pump has a maximum capacity of 1.8 L/min. The maximum dosage available with one metering pump operating is 0.8 and 1.2 mg/L for 1000 and 650 ML/d, respectively.

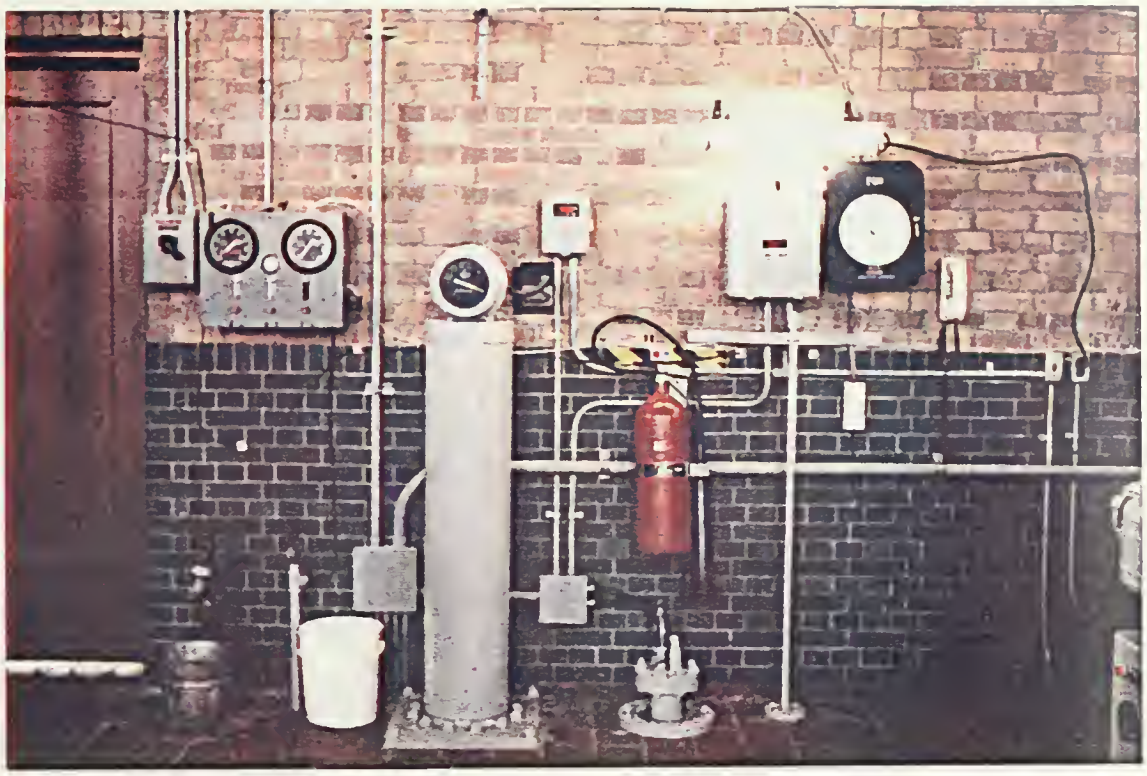
The application point is in the reservoir output channel.

C.4 Photographs

Following is a series of photographs which illustrate major components and chemical feed systems.

FILTER BUILDING

FRONT - FLUORIDE BUILDING
BACK - FILTER BUILDING

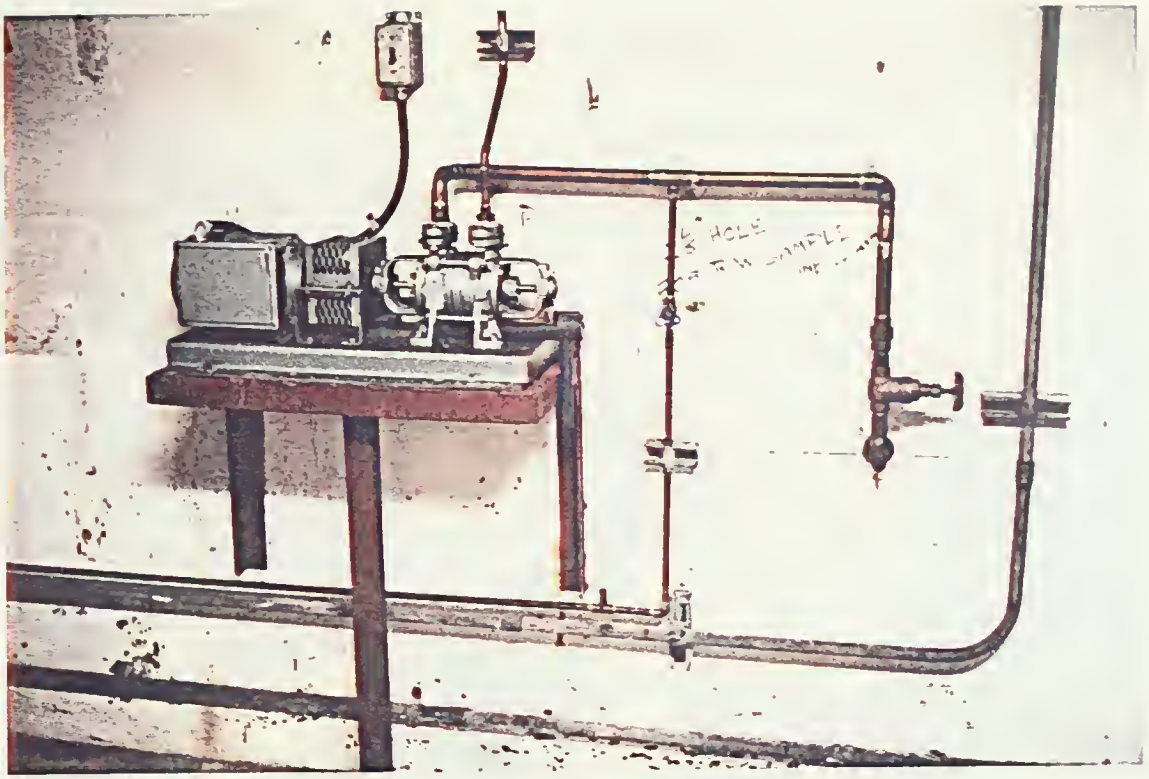


INTAKE WELL LEVEL AND RAW WATER TEMPERATURE

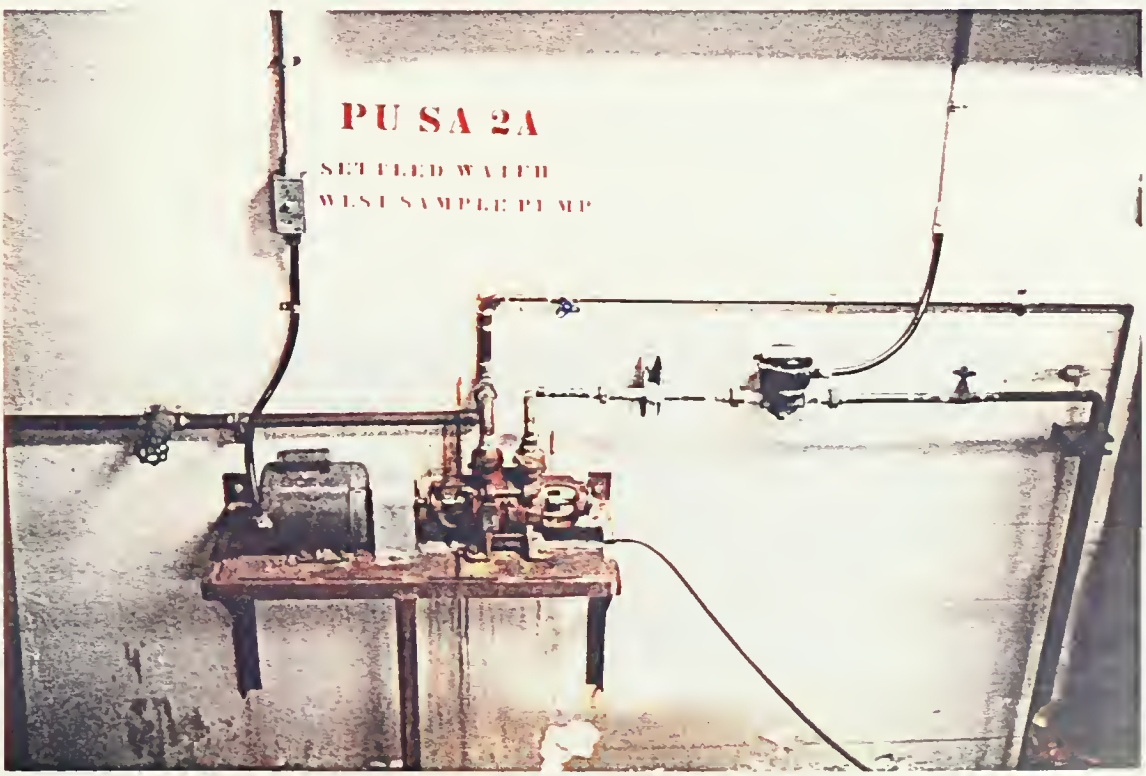
TRAVELLING WATER SCREENS

RAW WATER PUMPS

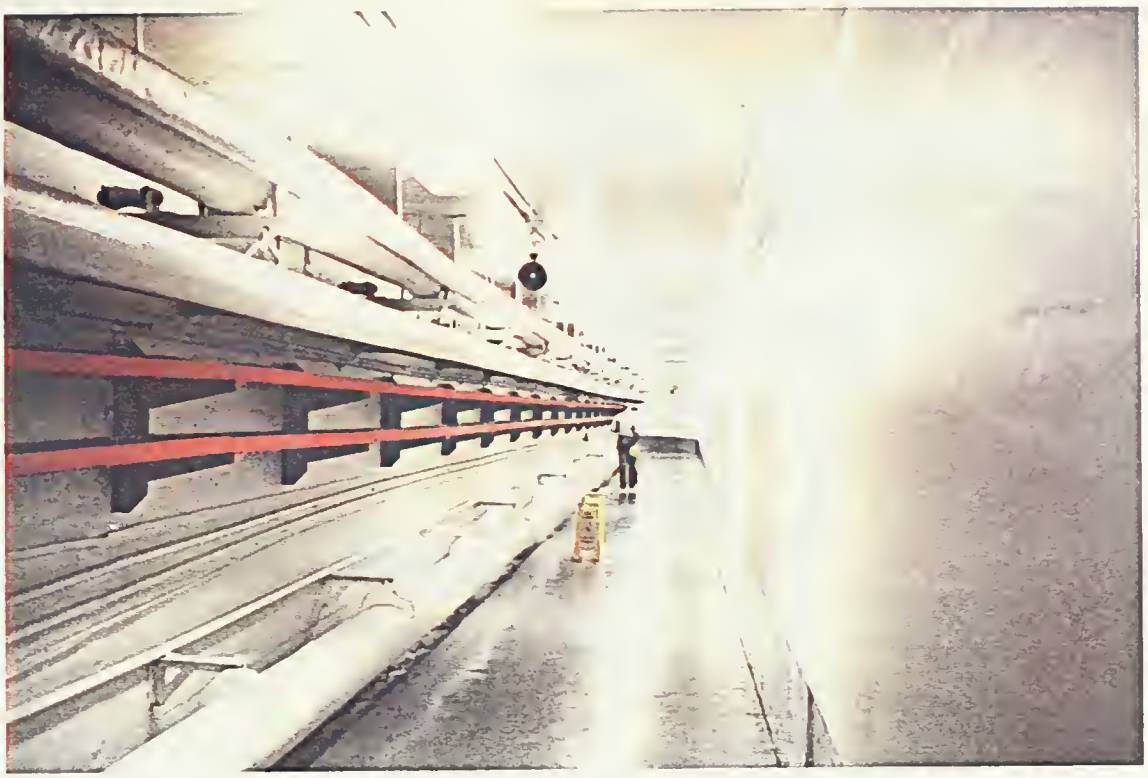
FRONT - RAW WATER VENTURI METERS
BACK - BACKWASH WATER VENTURI METER



PRE-FLOCCULATION SAMPLE PUMP



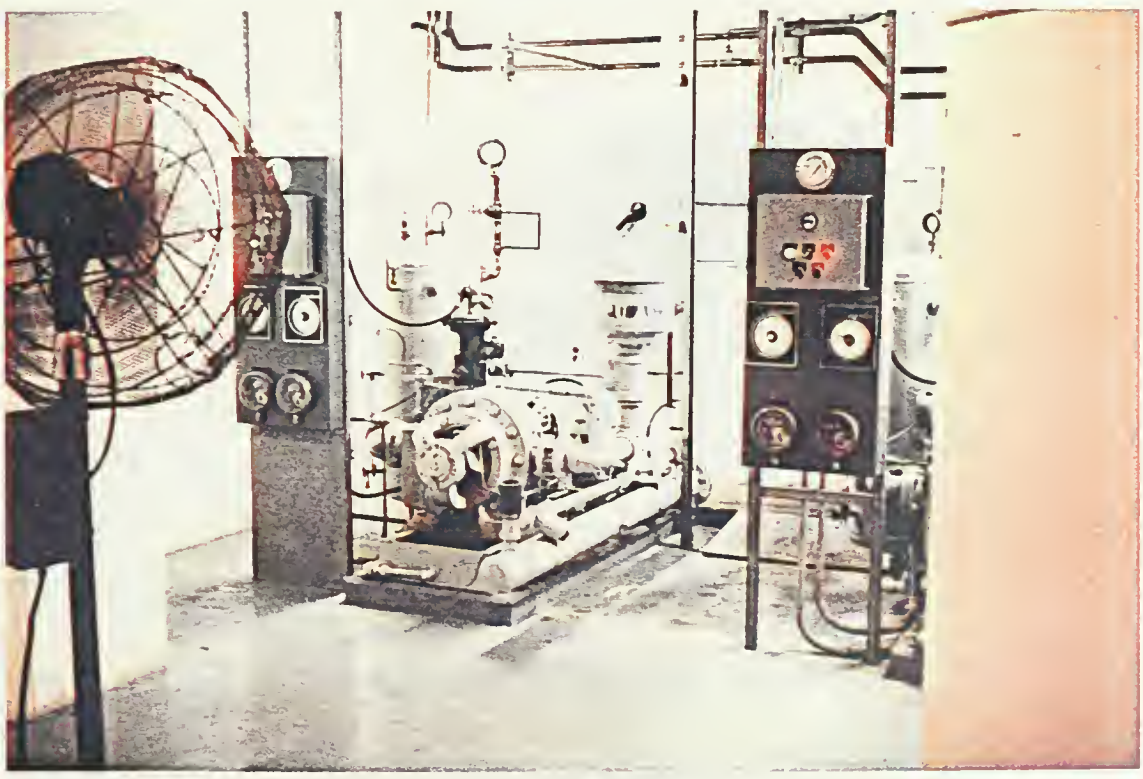
SETTLED WATER SAMPLE POINT



TUNNEL BETWEEN PUMP HOUSE AND FILTER BUILDING

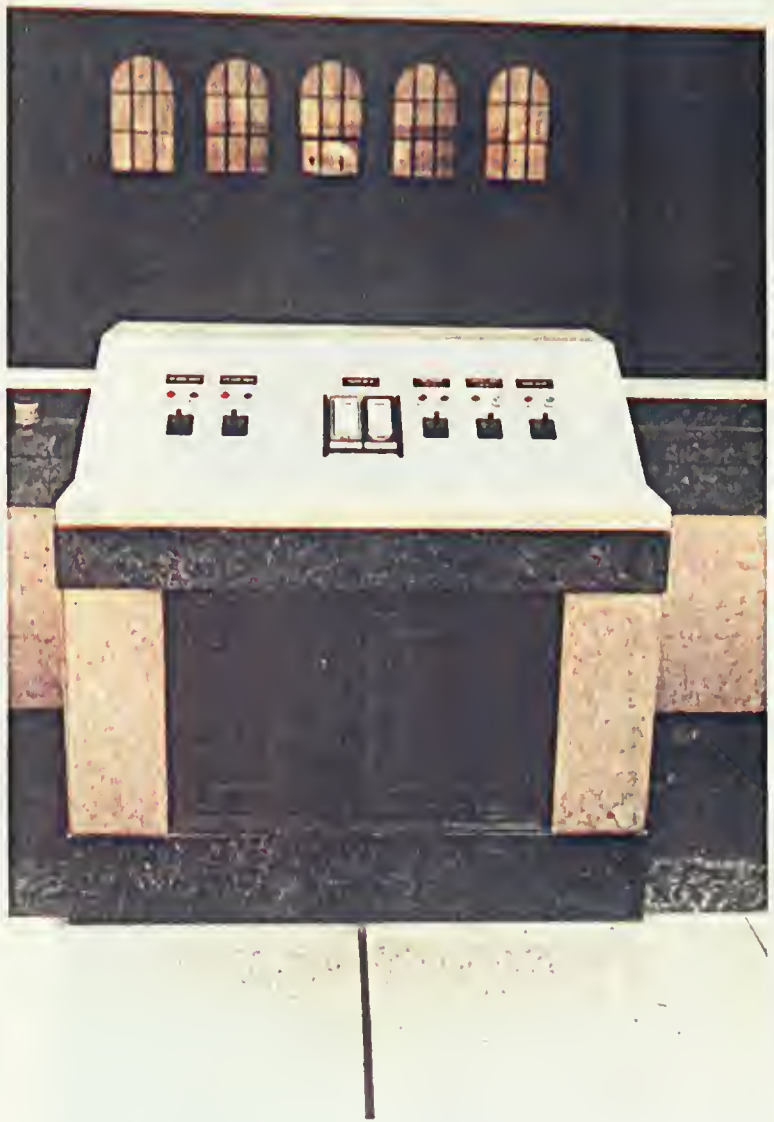
BURIED FLOCCULATION AND SEDIMENTATION TANKS

OPERATOR'S LAB

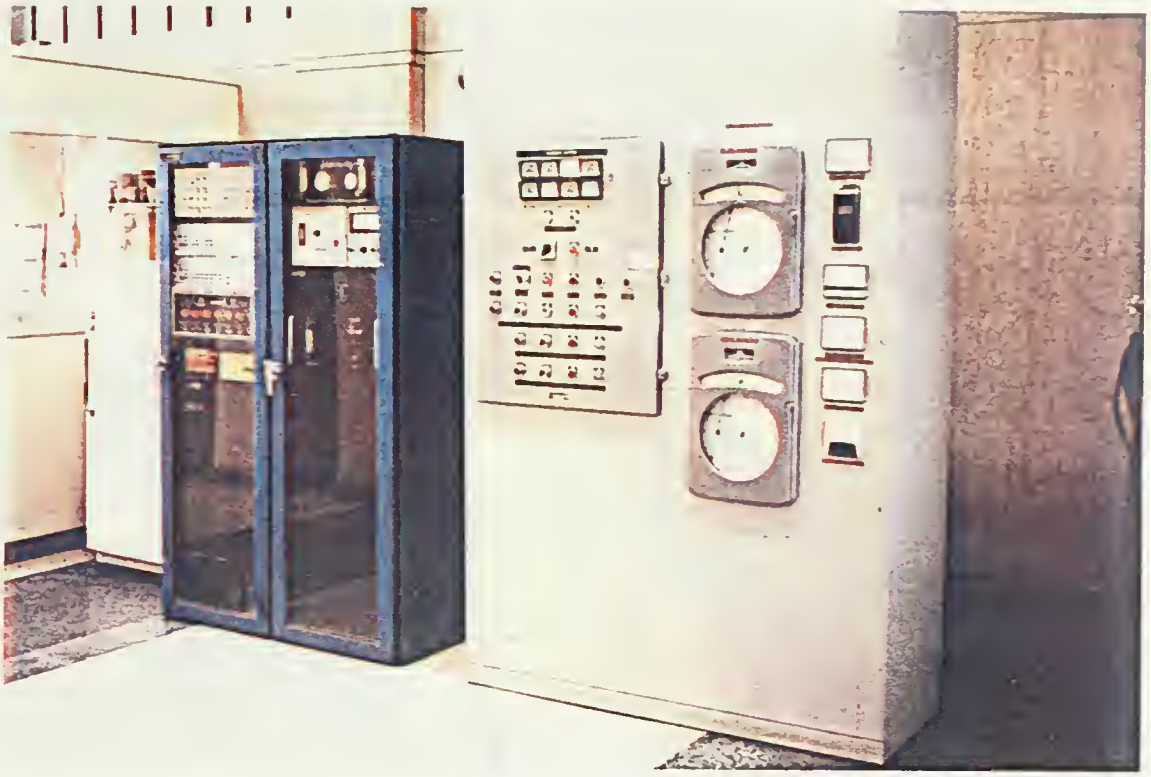


AIR COMPRESSORS

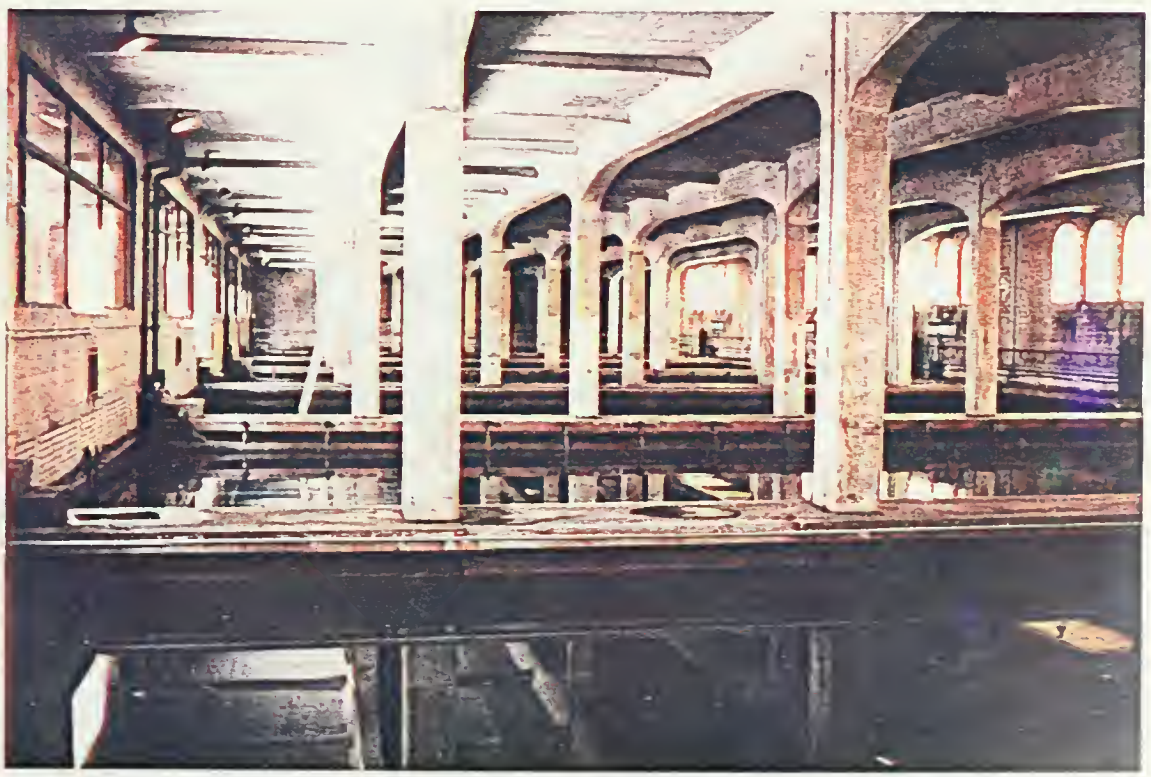
FILTER GALLERY



FILTER CONTROL PANEL

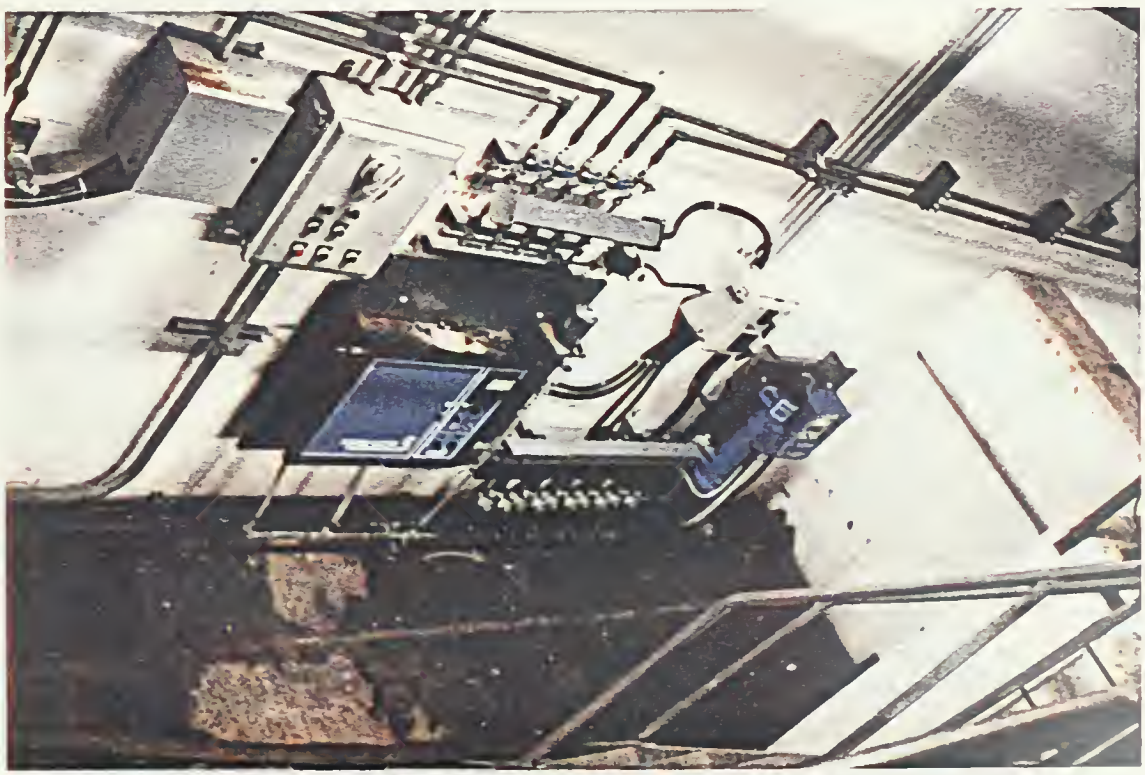


ALARM PANELS IN FILTER GALLERY

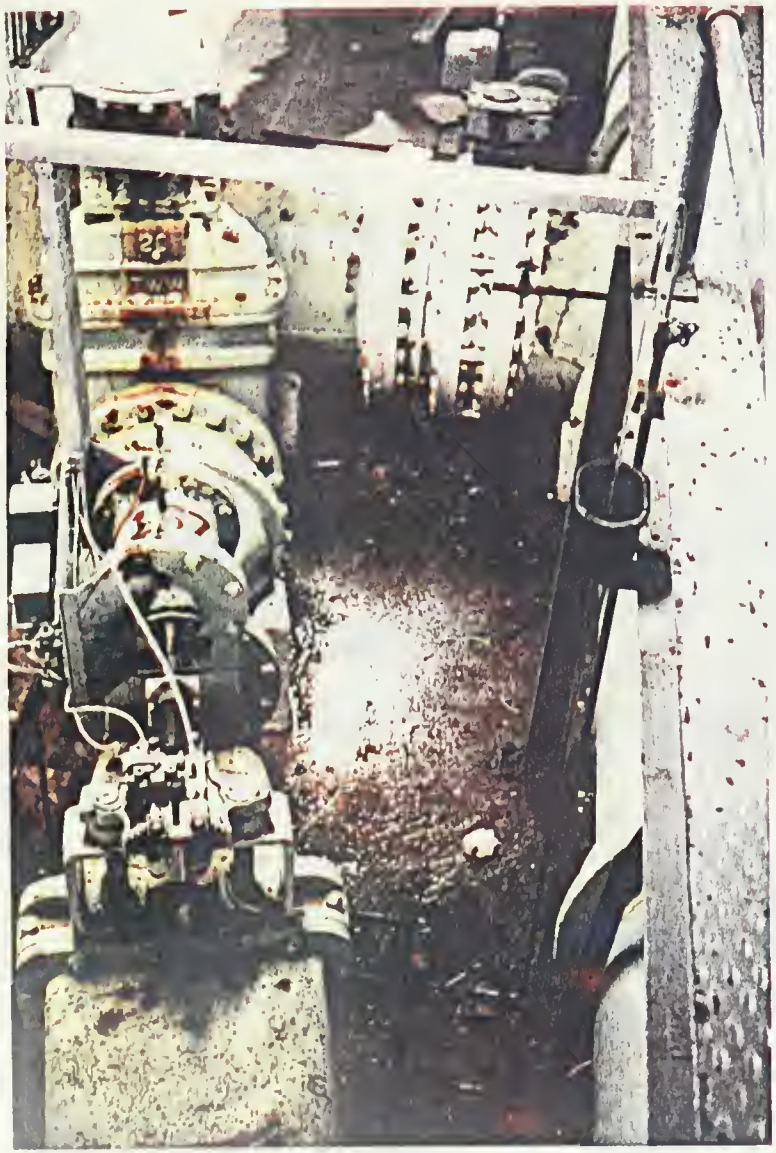


FILTERS

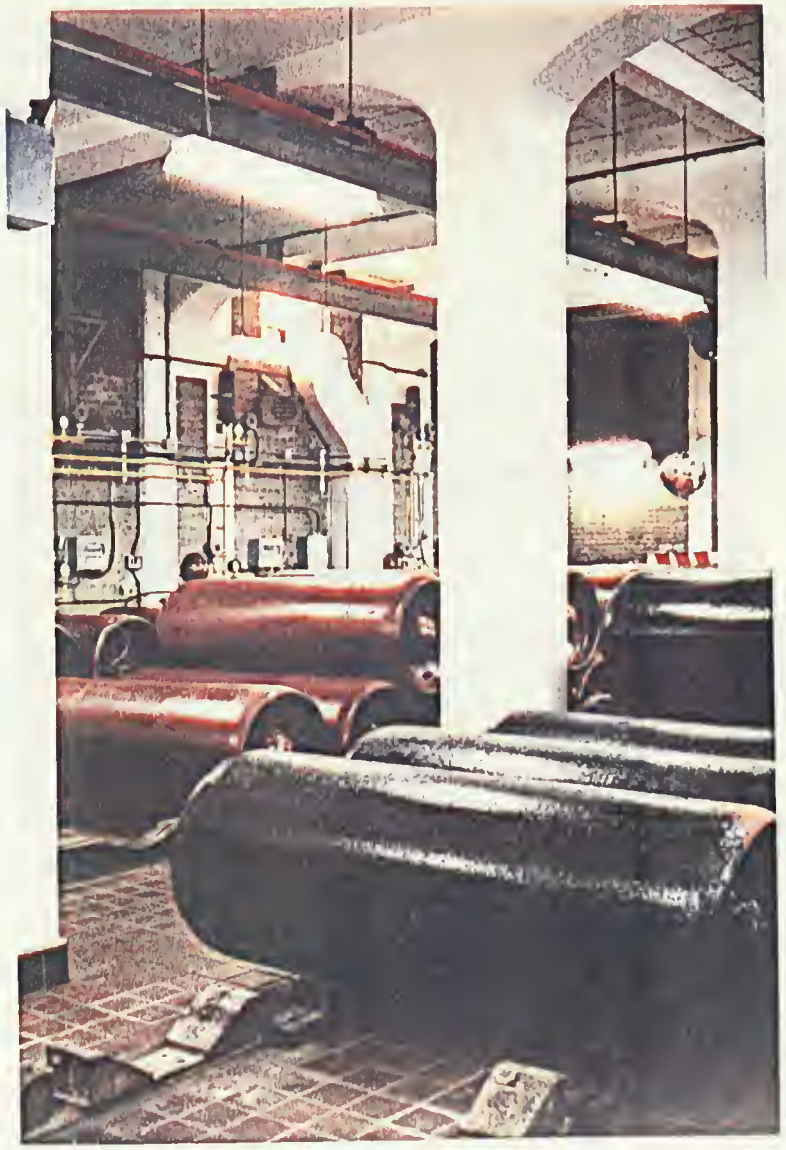
PIPE GALLERY



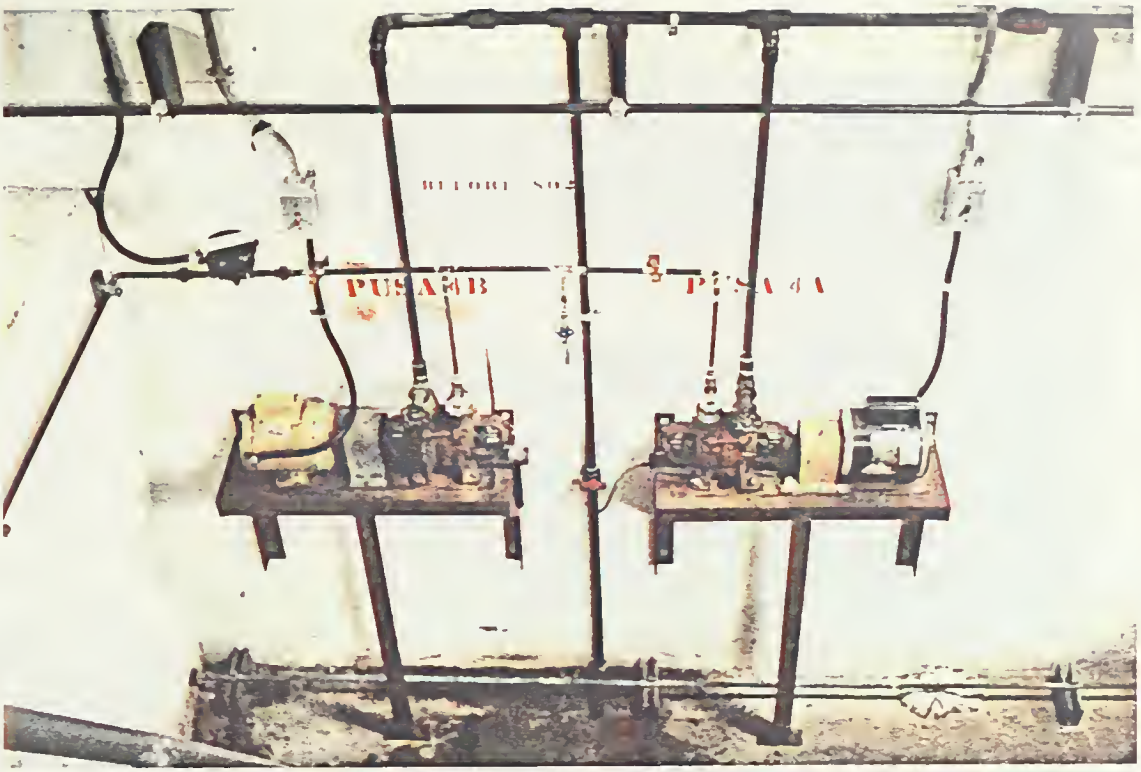
FILTER EFFLUENT TURBIDIMETER



PIPE GALLERY

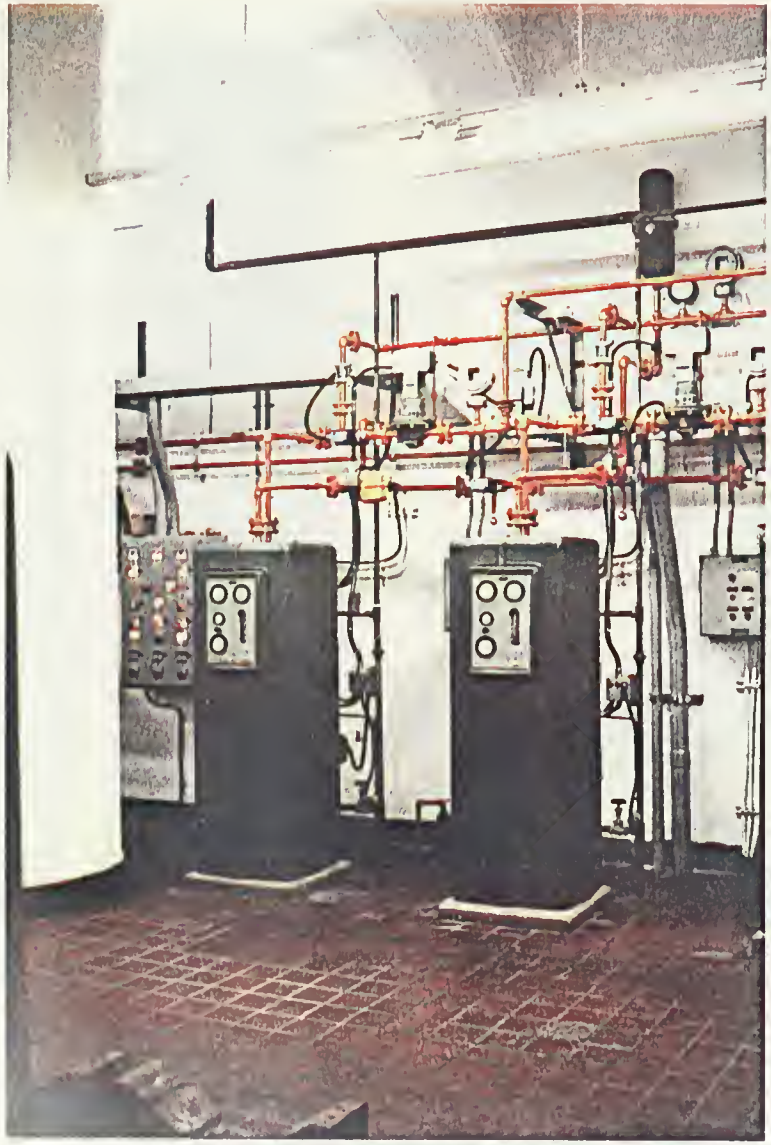


CHLORINE AND SULPHUR DIOXIDE CONTAINERS



BEFORE SO_2 SAMPLE PUMP

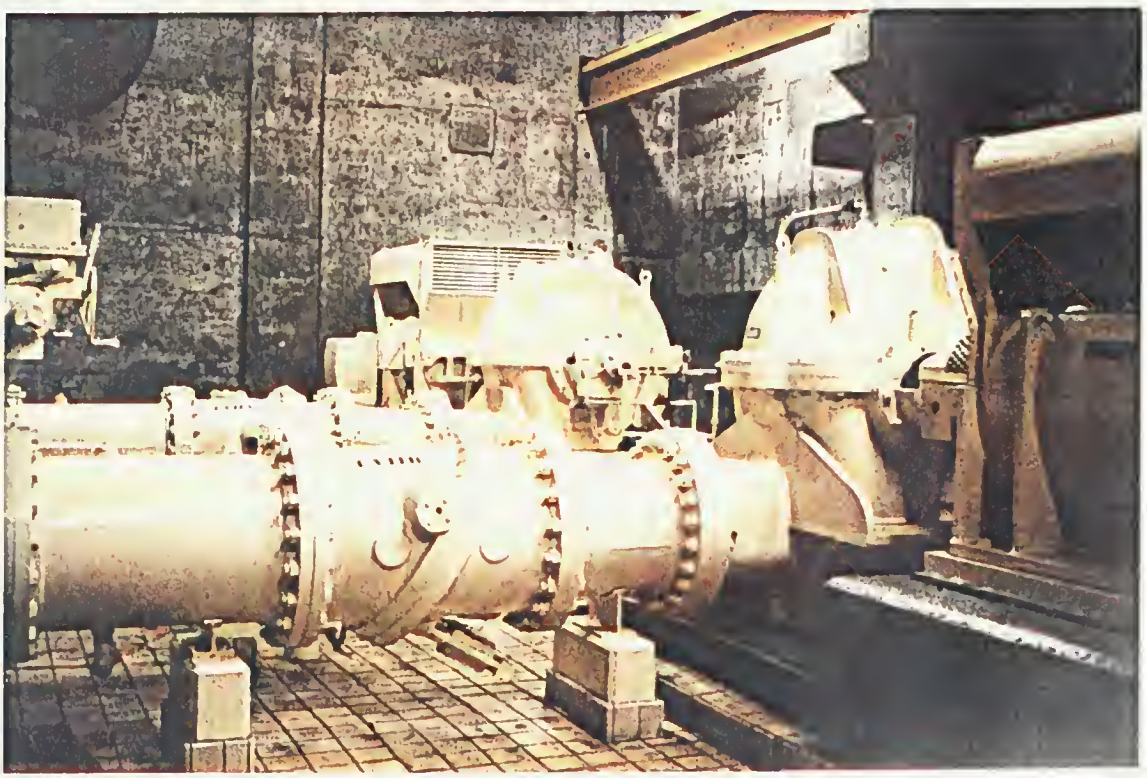
AMMONIA DAY TANKS



EVAPORATORS

CHLORINATORS AND SULPHONATORS

TREATED WATER PUMPS



SCARBOROUGH RESERVOIR TREATED WATER PUMPS

SECTION D
PLANT OPERATION

SECTION D
PLANT OPERATION

D.1 Description

(a) General

The original 1941 plant has 20 filters, and the 1958 expansion added another 20 filters. The plant is divided into East and West Sections, and is presently rated at 1,000 ML/d.

The plant is in the middle of installing a computerized system which includes an automated process control system and on-line status reporting. The system is expected to be operational in late 1987 or early 1988.

(b) Personnel

The R.C. Harris Water Filtration Plant is a large plant with many staff who have various levels of responsibility. The table below outlines the job responsibilities of the operations staff at each level. A similar chart exists for the quality control staff. Communications between the two staff branches occurs through the upper management levels.

(b) Personnel (cont'd)

DIRECTOR

ASSISTANT DIRECTOR

QUALITY CONTROL OFFICER				CHIEF SUPERINTENDENT - OPERATIONS			
Harris	Easterly	Island	Clark	Harris	Easterly	Island	Clark
↓				↓			
Chief Chemist				Chief Works Supervisor (Operations)			
↓				↓			
Chemists				Grade 1 Supervisor (Assistant to Chief Works Supervisor)			
↓				↓			
Chemist's Assistants (Grade 1)				Filtration Control Officer (Shift Supervisor, 24 hours)			
				↓			
				Filtration Plant Operator, FPO (manned 24 hours, responsible for data throughout plant and general operation of plant)			
				↓			
				Filtration Plant Assistant, FPA1 (Grade 1) (manned 24 hours, chemical operator who monitors residuals, turbidities, etc.)			
				↓			
				Filtration Plant Assistant, FPA2 (Grade 2) (responsible for chemical deliveries, and training for higher operation position, etc.)			
				↓			
				Filter Operator, PO4 (responsible for backwashing, etc.)			

(c) Flow Control

RAW WATER

The appropriate number of raw water pumps are turned on or off by a plant operator to produce the required amount of water to ensure that the reservoir level is appropriately high. There is a reservoir overflow in the case of an emergency.

Both sections of the plant are fed raw water via two raw water headers. An appropriate combination of raw water pumps is operated to adjust flow to maintain the reservoir level within a one metre band.

PRETREATMENT AND SEDIMENTATION

All of the flocculation and settling tanks are used all of the time, except during the once a year cleaning of the tanks.

FILTERS

All filters are not used all the time. The number of filters and respective filter rates of the East and West Sections are determined by the filtration plant operator (FPO) to match the raw water pumping rate. The filter rates are constant, however, they may be changed several times during a day depending on the pumping rate.

TREATED WATER PUMPING

The Central Pumping Control (CPC) located at the High Level pumping station in Metro Toronto directs how much water the R.C. Harris Plant needs to produce.

Central Pumping Control (CPC) determines the number and size of treated water pumps that are required to maintain system pressure and reservoir levels. The appropriate pumps are turned on or off remotely from CPC. An operator at the R.C. Harris plant is notified by Central Control before a pump is turned on or off. There is a telephone designated for communication with CPC.

(d) Filter Backwashing

The main criterion for initiating a backwash at the R.C. Harris plant is time, however, a filter will be backwashed if the filter effluent turbidity exceeds 0.5 FTU or if the terminal headloss is reached.

Prior to November 1986, filter runs averaged 5 days (120 hours) during the non-summer months. The maximum allowable filter run length has since been revised to 3 days (72 hours). Metro found that an easier and better cleaning of the filter bed could be achieved with more frequent backwashing. During the summer months, filters will be backwashed before 72 hours if the head loss through the filter reaches 1.5 m. If algae episodes are encountered, which may occur two to three times per year, the filter runs may be reduced to less than 24 hours.

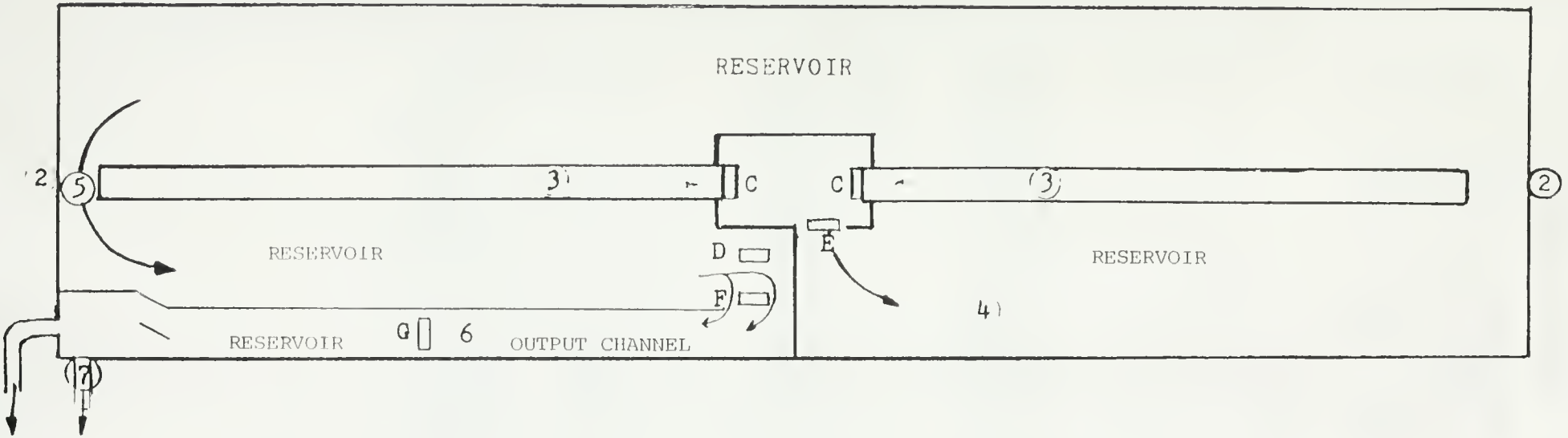
The low and high wash rates of 20 and 35 m/h provide a bed expansion of 4% and 19%, respectively, at 15°C. Our experience indicates that the high wash rate should provide a bed expansion of approximately 10% to 35%.

As noted earlier, the volume of water used during a backwash is approximately 4 m^3/m^2. Our experience indicates that a wash volume of 4.0 - 5.0 m^3/m^2 should properly clean a filter bed.

(e) Monitoring of Filters

Each group of five filters is monitored by a turbidity station using a Hach 1720B. Any one of the five filter effluents can be monitored by opening the appropriate solenoid valve. Normally, the turbidity station automatically rotates from filter to filter in a predetermined sequence. Each filter effluent is monitored for approximately one half hour. This turbidity system is used to monitor plant performance with respect to particulate removal. At the present time, a backwash is initiated if the filter effluent turbidity exceeds 0.5 FTU.

Following the installation of the supervisory control system, a Hach Surface Scatter Turbidimeter will continuously measure the spent wash water turbidity during the backwash. The spent wash water turbidity will be one of the criteria used to terminate the backwash. Metro plans to conduct tests to determine what turbidity value will be used to terminate the wash.



APPLICATION POINTS		SAMPLING POINTS	CHLORINE RESIDUAL ANALYZERS
A **Alum**	▭	1 Raw Water	
B **Pre-Chlorine**	▭	2 Settled Water	
C **Post-Chlorine**	▭	3 Filtered Water	Filtered W
D **Final Chlorine**	▭	4 Reservoir Inlet	After Post Cl_2
E **Fluoride**	▭	5 Reservoir Before SO_2	Before SO_2
F **Sulphur dioxide**	▭	6 Reservoir Before NH_3	After SO_2 (before NH_3)
G **Ammonia**	▭	7 Reservoir Outlet	Output (after NH_3)

1986-10-30

FIGURE 2

(f) Chemical Dosage Control

There are presently four chemical application points in the R.C. Harris plant. Pre-chlorine and alum are added at the intake well. Post-chlorine and fluoride are added at the reservoir entrance. Sulphur dioxide and final chlorine are added at the entrance to the reservoir output channel. Ammonia is added in the reservoir output channel.

See Figure 2, opposite, for chemical application points.

The chemical used for particulate removal is alum.

PRE-CHLORINE

The pre-chlorine dosage is set at 0.8 mg/L. The chlorine dosage is verified by weigh scale readings of the pre-chlorine containers, taken every hour. The free chlorine residual of the filtered water is continuously analyzed, and has an annual average of about 0.2 mg/L.

Superchlorination is practiced when the free chlorine residual of the filtered water is below 0.2 mg/L, when the raw water free ammonia is greater than 0.02 mg/L, or when the composite filtered water turbidity exceeds 0.5 FTU. At other times, the superchlorination process is not practiced.

ALUM

Raw water quality changes are gradual and relatively small.

Jar tests are not conducted at the R.C. Harris plant. Alum dosages are usually determined by raw water turbidity. The operator uses the raw water turbidity/ dosage table reproduced on the following page in order to select the proper alum dosage (if the filtered water turbidity exceeds 0.5 FTU, the alum dosage is increased, however, this seldom occurs).

(f) Chemical Dosage Control (cont'd)

Raw Water Turbidity (FTU)	Alum Dosage (mg/L)
0 - 5	3
6 - 10	5
11 - 20	7
21 - 50	10
55 - 100	15

At present, the alum dosage is set manually by a gravity fed rotameter. The dosage is checked hourly by a visual inspection of the rotameter by the filter operator (P04). As indicated earlier, if the filtered water turbidity rises above 0.5 FTU, the operator would increase the alum dosage to the next level.

Daily alum usage is determined by measuring the level drop in the alum storage tanks. The accuracy of this method appears to be adequate (at 400 ML/d and 3 mg/L alum, the 24 hour level drop would be approximately 9 cm).

FLUORIDE

Fluoride is added to the water in the form of hydrofluosilicic acid. The acid is fed by one of two metering pumps which are flow (speed) paced by the filtered water flow.

The fluoride dosage ranges from 0.95 to 1.15 mg/L, with a monthly average of 1.0 to 1.1 mg/L, to maintain a plant effluent concentration of 1.2 mg/L. Dosages and acid usage are checked by day tank weight readings, taken hourly. Day tanks are refilled when the scale reading drops below 150 kg.

The fluoride concentration in the plant effluent is monitored by six spot checks and one composite sample test performed by the quality control lab.

(f) Chemical Dosage Control (cont'd)

POST-CHLORINE

The post-chlorine dosage is applied to the filtered water at the entrance to the reservoir. The dosage is determined by the concentration of free ammonia in the raw or settled water, whichever is greater. (The post-chlorine dosage is increased to 1.5 mg/L if the filtered water turbidity exceeds 0.5 FTU). The operator checks the free ammonia levels every 2 hours, and then selects the proper post chlorine dosage using the free ammonia/post-chlorine dosage table reproduced below.

FREE AMMONIA (mg/L)	POST CHLORINE DOSAGE (mg/L)
less than 0.020	0.3 - 1.5
0.02 - 0.05	2.0 - 2.5
0.05 - 0.10	2.5 - 3.0
0.10 - 0.20	3.0 - 3.5
0.20 - 0.30	3.5 - 4.0
0.30 - 0.40	4.0 - 5.0
0.40 - 0.50	5.0 - 6.0
0.50 - 0.60	6.0 - 7.0
0.60 - 0.70	7.0 - 8.0
0.70 - 0.80	8.0 - 9.0
0.80 - 0.90	9.0 - 10.0
0.90 - 1.00	10.0 - 11.0

The post chlorine dosage is automatically paced by the total filtered water flow.

Higher post chlorine dosages than those displayed in the preceding table may occasionally be necessary to maintain the required chlorine residuals. The required free chlorine residual at the After Post Chlorine sampling point (see Figure 2) varies depending on the raw or settled water free ammonia level, as shown in the table below.

(f) Chemical Dosage Control (cont'd)

	Free Cl_2 Residual After Post Cl_2 (mg/L)
Raw or Settled Water Free Ammonia <0.02 mg/L	0.65 - 0.75*
Raw or Settled Water Free Ammonia >0.02 mg/L (Superchlorination)	1.5 (minimum)
Filtered Water Free Cl_2 Residual <0.2 mg/L	1.5 (minimum)
Raw Water Free Ammonia ≥0.20 mg/L	2.5 - 3.0+

* The free chlorine residual is maintained at 0.75 - 0.85 mg/L between October and May.

\+ Until the higher Free Ammonia is detected in the settled water, then return to the original dosage as indicated in the operations manual.

The post-chlorine free residual is continuously analyzed in several locations; at the reservoir inlet (following post chlorine), in the reservoir (before sulphur dioxide), and at another location in the reservoir (after sulphur dioxide, before ammonia). The post-chlorine total residual in the plant effluent is also continuously analyzed.

Chlorine dosage is verified by weigh scale readings of the post-chlorine containers, taken every hour.

SULPHUR DIOXIDE (SO_2)

A compound loop control system for sulphur dioxide is used, based on chlorine residual. Sulphur dioxide is added when the free chlorine residual at the end of the reservoir, before the SO_2 application point, is greater than 0.6 mg/L.

(f) Chemical Dosage Control (cont'd)

Sulphur dioxide is applied at the entrance to the reservoir output channel, and is paced by the total output plus backwash flow. Sulphur dioxide is used for dechlorination to lower the free chlorine residual to 0.45 - 0.55 mg/L at the after SO_2 sample point. This free chlorine residual is increased to 0.55 - 0.65 mg/L between October 15 and May 15 because the Metro wastewater treatment plants do not chlorinate during these months.

Sulphur dioxide dosages range from 0.15 to 4.2 mg/L. Sulphur dioxide usage and dosages are verified by weigh scale readings of the cylinders, taken every hour.

FINAL CHLORINE

Final chlorine is added only when there is a malfunction in the post-chlorine system.

AMMONIA (NH_3)

Aqueous ammonia (28%) is added in the reservoir output channel. Ammonia dosages are based on free chlorine residuals after SO_2, as shown in the table below.

Free Cl_2 Residual After SO_2 (mg/L)	Ammonia Dosage (mg/L)
0.40	0.13
0.45	0.15
0.50	0.17
0.55	0.18
0.60	0.20
0.65	0.22
0.70	0.23

(f) Chemical Dosage Control (cont'd)

Dosage adjustments are based on the average free chlorine residual (after SO_2) for the day, and are usually only adjusted when the after SO_2 chlorine residual specification changes. Ammonia dosages are accurately calculated from the hourly day tank weight readings. Dosages generally range from 0.17 to 0.20 mg/L.

The concentration of free ammonia in the plant effluent normally ranges from 0.1 to 0.25 mg/L. If this concentration should exceed 0.4 mg/L, the ammonia equipment would be immediately shut down, as this indicates a problem in the process operation.

(g) Quality Control Testing

The following table lists information on the sample lines in the operator's lab. This table does not include sample lines to continuous chlorine residual analysers or continuous turbidity metres.

SOURCE*	SIZE (mm)	FLOW (L/min)	VELOCITY (m/s)	MATERIAL	
		Norm.	Norm.	Suct.	Dischg.
Raw Water	12.7	1.5	0.20	PVC or Cu	Cu
Settled	12.7	2.6	0.34	Cu	PVC
Filtered	12.7	1.4	0.18	Cu	Cu
Post	12.7	3.1	0.41	PVC	Cu
Before Dechlorination	12.7	2.3	0.30	PVC	Cu
After Dechlorination	12.7	1.8	0.24	PVC	PVC
Output	12.7	1.3	0.17	Cu	PVC

* See Figure 2 for location of sample points.

(g) Quality Control Testing (cont'd)

These flow rates were determined by performing a time displacement test on the sample taps in the operator's lab. The operator lab and main lab sample lines are back flushed for 15 minutes once per week.

Each sample point has two sample lines, one leading to the operator's lab, the other to the main process control lab. Most of the in-plant monitoring tests, such as chlorine residual and turbidity, are conducted by filtration plant assistants (FPA1) at their lab. Tests conducted by the main process control lab, such as fluoride residual, are conducted on samples taken at the source or samples from the operator's lab, located in the filter gallery.

The following table lists the tests conducted in the plant and identifies who performs each test. All of the in-plant monitoring is reviewed for quality control by the main process lab. In addition to regular analysis, further testing and investigation is conducted as a response to any unusual results.

(g) Quality Control Testing (cont'd)

IN-PLANT MONITORING

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT	TESTING LAB
Cl_2 Residual					
- Pre-free	Filtered Water	Continuous	1/30 min.	F&P residual analyzer	Operator's Lab
- Pre-free	Filtered Water	Irregular (1)	Irregular (1)	Fisher & Porter Amperometric Titrator	Operator's Lab
- Post-free	Reservoir Inlet	Continuous	1/30 min.	F&P residual analyzer	Operator's Lab
- Post-free	Reservoir Inlet	Irregular (1)	Irregular (1)	Fisher & Porter Amperometric Titrator	Operator's Lab
- Post-free	Reservoir Before SO_2	Continuous	1/30 min.	F&P residual analyzer	Operator's Lab
- Post-free	Reservoir Before SO_2	Irregular (1)	Irregular (1)	Fisher & Porter Amperometric Titrator	Operator's Lab
- Post-free	Reservoir Before NH_3	Continuous	1/30 min.	F&P residual analyzer	Operator's Lab
- Post-free	Reservoir Before NH_3	Irregular (1)	Irregular (1)	Fisher & Porter Amperometric Titrator	Operator's Lab
- Post-total	Reservoir Outlet	Continuous	1/30 min.	F&P residual analyzer	Operator's Lab
- Post-total	Reservoir Outlet	Irregular (1)	Irregular (1)	Fisher & Porter Amperometric Titrator	Operator's Lab
Turbidity	Raw	Continuous	1/2 hours	Hach Surface Scatter Turbidity Meter (0-10 FTU)	Operator's Lab

(g) Quality Control Testing (cont'd)

IN-PLANT MONITORING

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT	TESTING LAB
Turbidity	Raw	Continuous	1/2 hours	Hach Surface Scatter Turbidity Meter (0-100 FTU)	Operator's Lab
	Settled	Continuous	1/2 hours	Hach 1720	Operator's Lab
	Filtered	Continuous	1/2 hours(2)	Hach 1720	Operator's Lab
	Filtered	Continuous (Rotates between 5 filters, 30 min. each filter)	Continuous(2)	Hach Turbidimeter Monitoring Stations	
	Output	Continuous	1/2 hours	Hach 1720	Operator's Lab
	Raw	Irregular(3)	Irregular(3)	Hach 2100A	Operator's Lab
	Settled	Irregular(3)	Irregular(3)	Hach 2100A	Operator's Lab
	Filtered	Irregular(3)	Irregular(3)	Hach 2100A	Operator's Lab
	Output	Irregular(3)	Irregular(3)	Hach 2100A	Operator's Lab
pH	Raw	Continuous	1/hour	Beckman 960B	Operator's Lab
	Raw	Daily	Daily	Fisher Accumet Model 630	Main Lab
	Settled	Daily	Daily	Fisher Accumet Model 630	Main Lab
	After Post-Chlorination	Daily	Daily	Fisher Accumet Model 630	Main Lab
	Output	Daily	Daily	Fisher Accumet Model 630	Main Lab

(g) Quality Control Testing (cont'd)

IN-PLANT MONITORING

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT	TESTING LAB
Free Ammonia	Raw	1/2 hours	1/2 hours	Distillation/ Nesslerization	Main Lab
	Settled	1/2 hours	1/2 hours	Distillation/ Nesslerization	Main Lab
	Before Ammoniation	1/8 hours	1/8 hours	Distillation/ Nesslerization	Main Lab
	Output	1/2 hours	1/2 hours	Distillation/ Nesslerization	Main Lab
Fluoride	Raw	2/week	2/week	Orion Research microprocessor ionanylzer Model 901	Main Lab
	Output	1/4 hours (4)	1/4 hours (4)	Orion Research microprocessor ionanylzer Model 901	Main Lab
Temperature	Raw	Continuous	1/2 hours	In-line probe	Operator's Lab
Algae Enumeration (including Zoo plankton)	Raw Settled Output	1/week 1/week 1/week	1/week (5) 1/week 1/week	Filtration and Microscope/ Whipple Cell Eyepiece	Main Lab
Bacteriological Testing	Raw	2-4/day	2-4/day (6)	Std. Membrane Filtration Apparatus	Main Lab
	Settled	2-3/day	2-3/day (7)	Std. Membrane Filtration Apparatus	Main Lab
	Filtered	0-1/day	0-1/day (8)	Std. Membrane Filtration Apparatus	Main Lab
	Output	6/day	6/day	Std. Membrane Filtration Apparatus	Main Lab

(g) Quality Control Testing (cont'd)

IN-PLANT MONITORING

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT	TESTING LAB
THM's	Raw	1/2 months	1/2 months	Varian 3400 Gas Chromatograph	Main Lab
	Output	1/2 months	1/2 months	Varian 3400 Gas Chromatograph	Main Lab
Total Solids	Output	2/year	2/year	Ceramic Dish/ Drying Equipment	Main Lab
Phenols	Raw	6/week	6/week	Bausch Lomb Spectrophoto-meter (Spectronic 700)	Main Lab
	Output	1/week	1/week		Main Lab

NOTE: Trace metal analysis is conducted on the raw and treated water once a month. The metals tested include: Ca, Mg, Na, K, Cu, Pb, Cr, Zn, and Mn.

NOTES:

(1) The amperometric titrator in the operator's lab is used once per shift (1/12 hrs.) to check the readings of the residual chlorine analysers. If the two results differ by greater than 0.1 mg/L, the continuous analyser is calibrated. The continuous analyser is calibrated during each shift, i.e. 12 hours.

(2) Turbidity monitoring stations are installed on filter effluents, and have recently been put into operation. A continuous turbidimeter also monitors the filter effluent composite.

(3) Turbidity is measured at four points in the plant by continuous metres. Operators check the continuous meters with the Hach 2100A turbidity meter in the operators' lab once per shift. If the readings are significantly different, the continuous meter is calibrated. The continuous meter is calibrated during each shift, i.e. 12 hours.

(g) Quality Control Testing (cont'd)

(4) In addition to the testing conducted on output samples every 4 hours, a 24 hour composite sample is collected. A portion of the composite sample is collected hourly. The composite sample is analyzed for fluoride concentration.

(5) Algae counts are done on raw, settled and output samples on any day where the number of backwashes is greater than thirty.

(6) Bacteriological testing is performed on raw water samples four times per day from Monday to Thursday, three times per day on Friday and twice per day on weekends and holidays.

(7) Bacteriological testing is done on settled water samples collected three times per day from Monday to Friday and twice per day on weekends and holidays.

(8) Bacteriological testing is done on a filtered water composite sample collected once per day from Monday to Friday. Bacteriological testing is also conducted on two filter effluents, sampled in rotation, once per day from Monday to Friday.

D.2 Operation and Process Concerns

(a) Chlorine/Sulphur Dioxide Storage

The chlorine and sulphur dioxide storage area is located adjacent to the filter gallery. The area is very cramped and does not provide adequate accessibility for deliveries. Chlorine cylinder deliveries occur about twice a week, and take approximately 2-3 hours to complete due to the difficulty in getting the cylinders in and out of the room. The cylinders are rotated so that the oldest cylinders are used first.

The storage area in the chlorine room is being increased by improving the present use of space. The total room area, however, is not changing.

(b) Alum Application Point

The present alum application point is in the raw water well. In the near future, the application point will be changed to the two raw water headers, immediately following the raw water venturi metres.

There are a number of reasons for changing the alum application point. The new location is on the discharge side of the low lift pumps, which will eliminate the problem of alum buildup in the low lift pumps. Secondly, having two flow-paced alum application points should provide more controlled alum dosing.

(c) Algae Episodes

Occasionally, during the spring and summer months, the plant will experience unusually high algae counts in the raw water. The main species are: tabellaria, fragilaria and melosira. The algae reduces the filter run lengths to less than 24 hours, and this can affect the total output of the plant. The algae do not appear to cause any taste and odour problems.

(d) Flow Metering and Leakage

In general, the raw and treated flow metres work quite well. There are occasional problems with the metering when, for instance, the treated water flow exceeds the raw water flow on a given day. These inaccuracies are not frequent.

A separate consideration is that there is leakage in the filter area to drain, and this will cause discrepancies between the actual measured flows and the amount of water produced.

(e) Wash Water System Leakage

The wash water system has experienced serious leakage in the past, through leaking valves. The wash water pump discharge check valves have been refurbished and the leakage decreased, however, some leakage still exists. Subsequent to this study period, the individual filter wash water valves have been adjusted, and almost no leakage occurs now.

Presently, the wash water tanks are not filled until immediately before a backwash because of leakage. A backwash is conducted by withdrawing the wash water tank volume and operating the three backwash pumps simultaneously.

SECTION E
PLANT PERFORMANCE (PARTICULATE REMOVAL)

SECTION E

PLANT PERFORMANCE (PARTICULATE REMOVAL)

E.1 Turbidity Removal

(a) General

The R.C. Harris plant must deal with raw water quality conditions as shown:

Turbidity (FTU)	0.3-40	(1)
Colour (HCU)	2-10	(2)
Iron (mg/L)	0.003-0.025	(2)
Manganese (mg/L)	0.001-0.002	(2)

Notes: (1) Taken from log sheets at the R.C. Harris plant.
(2) Taken from DWSP.

Slightly higher turbidities are usually experienced during the winter/spring period, i.e. December - April. The table below shows the range of turbidity conditions for the two raw water quality periods.

1983-86	RAW WATER TURBIDITY (FTU)		
	MAX.	MIN.	AVG.
Winter/Spring (Dec. - Apr.)	40.0	0.2	1.67
Summer/Fall (May - Nov.)	26.0	0.3	0.99

(b) Plant Performance

OVERALL PLANT PERFORMANCE

It is usual to consider two conditions for plant operation, the maximum hydraulic flow rate and the maximum process flow rate. The maximum process condition, from the stand point of particulate removal, occurs with the highest solids loading on the plant. The plant output at R.C. Harris remains fairly constant all year; therefore, the maximum process condition corresponds to the worst water quality condition.

(b) Plant Performance (cont'd)

The plant records for treated water during both water quality periods are summarized below:

1983-86	TREATED WATER TURBIDITY (FTU)		
	MAX.	MIN.	AVG.
Winter/Spring (Dec. - Apr.)	0.86	0.05	0.21
Summer/Fall (May - Nov.)	1.0	0.05	0.25

These figures and tables indicate that the particulate removal performance of the R.C. Harris plant is very good. At no time in the 1983 - 1986 period did the plant effluent turbidity exceed 1.0 FTU, based on bi-hourly readings.

ASSESSMENT OF OVERALL PERFORMANCE

The turbidity guideline in the Province of Ontario is 1.0 FTU; but it is important to reduce the turbidity to as low a level as practical.

The above numbers illustrate the consistently good quality of the treated water at the R.C. Harris plant. The graph included in Appendix C as Figure 1.1 shows a Composite Performance Profile of Treated Water Turbidity Ranges for the period 1983 - 1986. Table 2.0 of Appendix A contains summarized turbidity data for the period 1983 - 1986.

The historic records of the plant have been reviewed as a means to assess plant performance under various operating conditions. Figures 2.0 and 2.1 in Appendix C illustrate the good correlation between raw water turbidity and alum dosage. As the raw water turbidity rose, the alum dosage was immediately increased.

E.2 Treatability Testing

(a) Jar Testing

TURBIDITY REMOVAL

Treatability testing was carried out on a raw water sample collected on November 22, 1986. The Laboratory and Treatability results sheets are included in Appendix D.

Alum and various polymers were used in the coagulation/flocculation/sedimentation testing followed by filtration through a 1.2 µm membrane which, in our experience, emulates the performance of a dual media filter. The results indicate that filtration down to a turbidity of <0.2 NTU is possible with a relatively low alum dosage.

For this particular raw water sample, the addition of a polymer with the alum did not significantly improve the flocculation/coagulation stage, or the treated water turbidity. The effectiveness of polymers should be examined with higher raw water turbidities. A polyelectrolyte may be required under these conditions to ensure the lowest possible filtered water turbidities.

ALUMINUM RESIDUAL

The use of aluminum salt coagulants (alum, polyaluminum chloride, etc.) in potable water treatment plants may lead to increased aluminum concentrations in treated water, which may result in water quality and supply problems.

There is no evidence that aluminum is physiologically harmful, and no health-related limit has specified anywhere in the world to our knowledge. However, the perception of potential health problems associated with aluminum frequently emerges.

(a) Jar Testing (cont'd)

Water supply problems may be associated with increased aluminum concentrations in treated water. These problems include the formation of a hydrous aluminum precipitate in the distribution system which may increase turbidity and complaints about clarity. Aluminum floc in the system may interfere with the disinfection process by entrapping and protecting microorganisms. Another problem attributed to increased aluminum concentrations is deposition of aluminum hydrolysis products on pipe walls, which decreases carrying capacity. To minimize these problems, the Ontario Drinking Water Objectives (ODWO) suggest an operational guideline of <0.1 mg/L as Al in the treated water leaving the plant.

An EPA survey of 186 utilities showed that a number of plants exhibited high residual aluminum when overdosing of alum occurred. Even though some utilities surveyed stated that minimizing the alum dosage is a strategy for controlling residual aluminum, underdosing of alum appears to be just as detrimental to turbidity removal and residual aluminum control as overdosing.

Water quality problems associated with high concentrations of aluminum in finished water have led to discussion of ways to reduce residual aluminum concentrations. One method of reducing aluminum concentration is to optimize coagulation. To have optimum coagulation requires that the best coagulant, dosage, and combination of operating conditions be selected for each raw water. The optimum pH range must also be achieved since aluminum is least soluble in water in the pH range 5.5-7.0.

There are treatment plants in Ontario which are currently using residual aluminum as an "operational tool" to optimize the dosge of alum. Operational staff respond to any elevation in residual aluminum and make the necessary adjustments to the plant operation.

(a) Jar Testing (cont'd)

Aluminum solubility in water is a complex topic; but some of the most significant variables are pH, time and temperature. For pH values greater than 6.5, the aluminum residual increases directly with pH. Aluminum residual is inversely proportional to time, up to several hours, whereupon the solubility concentration remains fairly constant. The aluminum residual is directly related to temperature, but this has a fairly minor impact over the ranges encountered in natural waters. For times greater than an hour and pH's greater than about 7.4, water may contain a residual concentration greater than 0.1 mg/L.

For the aluminum residuals and pH values found in the waters at the plant, the results are consistent with general experimentally determined values. Therefore, it is not surprising to find aluminum concentrations greater than 0.1 mg/L.

A minimum of daily monitoring of aluminum residual and pH leaving the plant is recommended by the Ontario Ministry of the Environment. An acceptable method of aluminum analysis should be used. Frequent examination of this data and Drinking Water Surveillance Program (DWSP) data will supply the needed information on the chemistry and fate of aluminum following water treatment to help operating authorities minimize the concentration of aluminum in the treated water.

(b) Optimum Particulate Removal

As discussed above, laboratory scale testing indicates that, under ideal conditions, the raw water particulate materials can be coagulated so as to yield low filtered water turbidities. It appears, from the laboratory testing, that an alum dosage of 2 to 4 mg/L is required to produce treated water with a turbidity of 0.2 NTU or less. An alum dosage of approximately 20 mg/L is required to produce treated water with an aluminum residual of approximately 0.1 mg/L (See test no. 6 and 7, Appendix D).

E.3 Optimum Removal Strategies

(a) Filtration

The number of filters and the filtration rates are presently governed by the demand for treated water, which Central Pumping Control requests. The lower the filtration rate, the better the removal performance. This can be achieved by operating all the filters all the time. From the standpoint of particulate removal, the ideal procedure would be to operate all the filters with a constant flow rate to satisfy some long-term demand. This procedure requires that the reservoir level rise and fall to offset the difference between production and demand flow rates.

Turbidity meters are installed on filter effluents, and have been put into operation recently.

It is our opinion that tests should be conducted on plant scale to determine the magnitude of improvement which would result from maintaining lower constant flow rates. These results should be assessed in light of the operational considerations.

SECTION F
PLANT PERFORMANCE (DISINFECTION)

SECTION F
PLANT PERFORMANCE (DISINFECTION)

F.1 Disinfection

At the R.C. Harris Water Treatment Plant, disinfection is practiced by pre-chlorination at the low lift pumping station, and post-chlorination after filtration. Post-chlorination is followed by the application of sulphur dioxide and ammonia. Data shown in Tables 3.0 and 3.1 in Appendix A show that the monthly average total chlorine dosage ranged from 1.3 to 3.0 mg/L. The application of ammonia and sulphur dioxide results in a total chlorine residual of about 0.70 mg/L.

F.2 Disinfection Efficiency

Tables 7.0 to 7.3 in Appendix A summarize the raw and treated microbiological data obtained for the R.C. Harris plant. Data is in the form of monthly minimum, maximum and average values and show that the microbiological quality of the water leaving the plant is good. Maximum values for total coliforms were greater than or equal to 5/100 mL in the treated water on four occasions during 1983 to 1986. Two results were 5 counts per 100 mL, one was 6 counts per 100 mL and another was 10 counts per 100 mL.

The data for fecal coliforms in treated water show that the Ontario Drinking Water Objective (ODWO) of no counts/100 mL was exceeded on two occasions during 1983 - 1986. On each occasion, the count was 1 fecal coliform per 100 mL. Fecal streptococcus was not found when tests were carried out.

In our opinion, the chlorine feed system seems to function adequately, but occasional bacteria counts occur. The procedure followed when positive bacteriological results occur is documented in Appendix G.

F.3 Chlorinated By-Products

TRIHALOMETHANES

Trihalomethanes (THM's) are the most widely occurring organics found in drinking water, and they also appear at the highest concentrations. The principal source of THM's in drinking water is the chemical interaction of chlorine added for disinfection, with humic substances that occur naturally in the raw water. There is some evidence that THM's are carcinogenic to animals. The Ontario Drinking Water Objectives for total trihalomethanes (TTHM's) is 350 µg/L.

Based on the limited data available on THM's (see Table F.1 and 5.1) for the R.C. Harris Water Treatment Plant, the levels of THM's found in treated water are well under the Ontario Drinking Water Objectives of 350 µg/L (0.35 mg/L). The annual average for 1983-85 was about 14 µg/L, as compared to 28 µg/L for 1986. It is probable that the difference may be attributable to a change in laboratories.

The 1986 total THM values were determined by the purge and trap method, which, for the treated water, ranged from 10 to 44 µg/L, with an average value of 28 µg/L. Therefore, it is our opinion that little should be done, at this time, to assess methods of reducing the THM's to lower levels.

TOTAL ORGANIC HALIDES

The terms of reference require consideration be given to the reduction of chlorinated by-products in the treated water. There was no complete set of information on the total concentrations of all organohalogen compounds.

It is our opinion that a broader measurement of chlorinated products should be considered and possibly a surrogate measurement should be utilized. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum total of all the organic halogen compounds.

TABLE F.1

Trihalomethane Data for R.C. Harris WTP

		1983(1)		1984(1)		1985(1)		1986(2)	
		R	T	R	T	R	T	R	T
JAN	Chloroform, µg/L							8(3)	0(3)
FEB	($CHCl_3$)								
MAR									
APR									
MAY									
JUN						1.6	5.7	0	23
JUL		<0.4	4.0	0.1	7.3	0	9.2	0	20
AUG						0	8.3	0	16
SEP	(4)			<0.2	4.2			0	17
OCT		0	4.8					0	9
NOV								0	5
DEC		0	6.22					0	6
JAN	Bromodichloro-							7(3)	0(3)
FEB	methane, µg/L								
MAR	($CHBrCl_2$)								
APR									
MAY									
JUN						1.5	3.8	0	14
JUL		0	5	1.6	6.7	0	0.4	0	13
AUG						0	4.5	0	11
SEP	(4)			<0.3	3.0			0	12
OCT		0	3.8					0	8
NOV								0	5
DEC		0	6.2					0	6
JAN	Chlorodibromo-							12(3)	0(3)
FEB	methane, µg/L								
MAR	($CHBr_2Cl$)								
APR									
MAY									
JUN						1.8	3.6	0	7
JUL		0	2.7	0	6.6	0	1.5	0	7
AUG							5.5	0	6
SEP	(4)			<0.3	3.5			0	6
OCT		0	<0.4					0	3
NOV								0	0
DEC		0	0					0	4
JAN	Bromoform, µg/L							0	0
FEB	($CHBr_3$)								
MAR									
APR									
MAY									
JUN								0	0
JUL		0	<0.4	0	0.4			0	0
AUG								0	0
SEP	(4)			<0.3	<0.4			0	0
OCT		0	<0.4					0	0
NOV								0	0
DEC		0	0					0	0

TABLE F.1 (cont'd)

		1983(1)		1984(1)		1985(1)		1986(2)	
		R	T	R	T	R	T	R	T
JAN	Total THM's, µg/L							27(3)	0(3)
FEB									
MAR									
APR									
MAY									
JUN						5	13		44
JUL		<0.4	<12	2	21	0	11		40
AUG						0	18.3		33
SEP	(4)			<1.1	11				35
OCT		0	<12						20
NOV									10
DEC		0	16						16
AVG.	Total THM's, µg/L	<0.2	<14	<1.3	12	1.6	14		28
RNG.	Total THM's, µg/L	0-<0.4	<12-16	<1.1-2	11-21	0-5	11-18		10-44

R - Raw water
T - Treated water

(1) 1983 - 1985 data from Metro Toronto; contract laboratories using purge and trap method without dechlorination.
(2) 1986 data from DWSP, purge and trap method without dechlorination.
(3) As reported, raw and treated values were probably interchanged.
(4) Averages of 3 values.

SECTION G
SHORT AND LONG-TERM MODIFICATIONS

SECTION G
SHORT AND LONG-TERM MODIFICATIONS

G.1 Description

This section includes feasible short and long-term process modifications required to approach optimum disinfection and particulate removal. It is important to understand that optimization of selected process steps may be in conflict with other aspects of the plant, such as staffing and budgeting costs. Estimated costs for each recommendation are also included.

The following short and long-term recommendations were provided, discussed, reviewed, and agreed upon at the plant site meeting.

We have assigned costs for each of the recommended works. Clearly, these costs may be reduced if Metro carries out the work.

G.2 Water Quality Testing

The MOE Region suggest that Metro increase the documentation on water quality, such as annual compilation of all data collected from private and Metro labs, summary of water quality data, numbers of samples, costs, personnel and special events sampling. This may be feasible when the data processing becomes computerized.

G.3 Flash Mixing

There can be two purposes for mixing of chemicals into the main process stream: blending and flash mixing. Blending consists of the distribution of chemicals uniformly throughout the body of the process stream and is characterized by relatively high velocity gradients of greater than 200 sec^{-1} for periods of up to several minutes. Flash mixing addresses the coagulation concept that blending must occur within a very short period of time, a matter of seconds, and this requires very high velocity gradients of greater than 1000 sec^{-1}. It is important to recognize the difference between these two concepts and their process implications. Blending mixing is to ensure that the process components will behave uniformly. Flash mixing has been espoused by some researchers in water chemistry as improving the coagulation process.

G.3 Flash Mixing (cont'd)

There is no flash mixing at the R.C. Harris Water Treatment Plant.

It is recommended that detailed laboratory and plant-scale tests be conducted to determine the value of flash mixing for the various flow and water quality conditions at this plant.

This work can be carried out at any time. The cost would be $10,000 to $15,000.

G.4 Streaming Current Monitor (SCM)

Accurate and timely adjustments to coagulant feed rates are vital to achieve optimum particulate removal. The purpose of the SCM is to permit a response to changing raw water conditions in a few minutes.

It is recommended that further study be conducted on the merits of SCM's. The merits of automating alum feeds should also be considered. If the tests demonstrate the reliability of SCM's, install two SCM's; one for each raw water header.

The testing of the SCM's should precede the investigation of flash mixing as it is an integral part of the evaluation of plant mixing. The study cost would be approximately $10,000, and the cost of each SCM is $10,000 to $20,000, depending on the associated equipment.

G.5 Filtration Rates

Presently at the R.C. Harris Water Treatment Plant, all of the filters do not operate all of the time. From the standpoint of particulate removal, the ideal procedure would be to operate all of the filters all of the time at a constant rate to satisfy a long-term demand.

G.5 Filtration Rates (cont'd)

It is recommended that Metro continue to carry out plant scale tests on the filters to determine the magnitude of improvement which would result from maintaining lower constant filter flow rates. Metro has suggested that the study should also investigate the merits of:

- Coagulant and filter aids
- Filter aids in the backwash
- Ramping a filter at start-up

G.6 Filter Cleaning

The volume of water used during a backwash at the R.C. Harris Plant is approximately 4 m^3/m^2. Previous experience has shown that a wash volume of 4.0 to 5.0 m^3/m^2 adequately cleans a filter bed, unless polymers are used.

It is recommended that the backwash procedure be investigated to determine the relative durations of the low and high backwash rates to provide an adequate backwash volume so as to maintain the long-term cleaning of the filter. This work should be conducted as soon as possible. The cost would be approximately $15,000.

Metro is presently investigating a backwash flow restriction in the centre gullet, and the backwash system in general is being examined.

G.7 Leakage

It is known that there is leakage in the filter area to drain, and this will cause differences between actual measured raw water flows and the amount of water produced. The wash water system also experiences leakage through the valves. Staff are aware of these and other leakage problems, and have a continual preventative maintenance (PM) program which regularly identifies and evaluates the efficiency of valves throughout the plant.

It is recommended that Metro continue to identify areas of leakage and budget for needed rehabilitation and repairs.

G.8 Chlorination Practices

The chlorine feed systems at the plant seem more than adequate to ensure proper disinfection, yet, on occasion, total coliform counts are experienced in the treated water.

The methods of bacteriological sampling and the test procedures are important factors in establishing good, repetitive results. Metro has investigated the sampling methods, and is satisfied that no problems exist here. When positive results are experienced, the procedure outlined in Appendix G is followed.

During the years of 1983 to 1986, four treated water total coliform counts were 5 cts/100 mL or higher, and two fecal coliform counts were 1 ct/100 mL. During the four years, approximately 8760 samples were taken (six output samples per day). The MOE believes that this frequency of occurrence is statistically acceptable.

It is recommended that Metro continue to investigate the transfer of chlorine into the water, including examination of flow rate regimes, contact times, and any other factors which may influence the chlorine transfer.

This work should be initiated immediately by plant staff.

G.9 Chlorinated By-Products

It is our opinion that a broader measurement of chlorinated by-products should be considered. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum total of all the organic halogen compounds.

It is recommended that the Province of Ontario develop a surrogate for measurement of chlorinated by-products.

G.10 Operating Instructions Manual

The ability to adequately familiarize staff with plant operating procedures is vital to the operation and management of a large water treatment plant. Metro Toronto has, and continually updates, an Operating Instructions Manual at each of the four water treatment plants. This manual constitutes a compendium of standard operating procedures and provides instruction on expected plant procedures. This is an excellent plant operations tool to ensure proper communications and to delineate responsibilities.

The table of contents from this manual is included in Appendix H.

It is recommended that this procedure be considered for other facilities in Ontario.

G.11 Aluminum Residual

The Ontario Drinking Water Objectives, 1983, Appendix B, Parameters Related to Aesthetic and Other Considerations, B.1.2 Aluminum states that:

> "the measure of residual aluminum in the treated water is important, not only to indicate the efficiency of the treatment process, but also because too high a residual aluminum can result in: (a) distribution system coating with consequent increased energy requirements, (b) interferences for certain industrial processes and (c) after-flocculation leading to consumer complaints.
>
> At present, there is no evidence that aluminum is physiologically harmful and no limit has been specified. A useful guideline to avoid the above problems is to maintain a residual below 0.1 mg/L as Al in the water leaving the plant."

It is recommended that a study be conducted, (1) to review the ODWO guideline of 0.1 mg/L, (2) to evaluate the chemical and treatment requirements needed to control aluminum residuals, and (3) to assess the operational and economic costs associated with aluminum residual control.

G.11 Aluminum Residual (cont'd)

This work should be conducted as soon as possible. The cost would be approximately $100,000.

G.12 Record of Information

The nature, frequency, and arrangement of information recorded about plant operations is vital to the operation and management of a water treatment plant.

The R.C. Harris Plant is currently installing a computer system, and the WPOS tables could be stored on this system. It is recommended that this information be kept at the plant and continuously updated. A particularly useful set of operating data is the Turbidity Profile through the plant. These records indicate the effects of changing conditions on specific operations through the process.

The Plant's record of information should also include the following:

- Process and piping diagram (PAPD)*
- Filter media characteristics
- Drawings
- Any data to be used in the future for operation of the Plant or design purposes.

* It is recommended that the PAPD be stored on a CADD system for ease of updating.

APPENDIX A
TABLES

TABLE 1.0: FLOWS (ML/d)

WPOS - R.C. Harris WTP

		1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	R	933.2	626.6	763.6	724.0	622.8	675.6	835.6	619.0	739.9	798.9	529.0	675.0
	T	894.2	578.3	705.0	694.2	512.9	647.6	810.2	553.5	707.4	718.5	460.5	607.8
FEB	R	889.3	531.1	645.2	741.5	646.5	711.5	881.6	659.8	746.0	810.3	586.1	717.5
	T	807.1	498.3	606.6	707.9	630.4	671.5	760.2	606.2	714.9	738.9	497.5	653.2
MAR	R	929.8	545.3	729.7	720.4	629.1	682.3	749.3	653.8	709.3	1045.9	630.1	797.4
	T	874.7	511.8	671.6	673.7	606.0	638.5	734.3	583.0	684.8	874.6	568.4	722.1
APR	R	1022.8	519.3	706.7	823.1	639.0	717.5	834.9	630.6	734.0	1043.0	636.2	913.3
	T	(988.3)	463.1	639.9	717.2	569.4	652.3	725.1	571.4	696.4	(913.3)	560.5	814.5
MAY	R	995.7	409.8	620.1	811.8	507.4	643.4	824.2	560.8	658.5	828.4	531.2	647.4
	T	894.6	375.0	556.8	710.9	452.6	567.0	733.7	455.2	605.2	719.2	455.5	570.6
JUN	R	916.8	522.9	659.9	876.7	522.7	646.8	813.9	543.4	662.6	977.5	668.2	767.6
	T	821.1	484.5	594.9	773.9	470.3	585.1	705.1	461.2	621.8	824.9	576.8	701.0
JUL	R	1020.1	552.3	749.9	904.4	533.6	672.1	900.4	568.4	675.0	896.2	600.4	794.6
	T	975.7	502.4	692.9	805.2	478.7	600.7	821.7	487.5	612.1	808.9	510.6	737.7
AUG	R	891.9	575.3	717.2	986.4	506.7	659.7	882.6	527.9	696.5	988.5	608.8	763.7
	T	803.3	521.4	658.1	(917.5)	478.8	620.1	(835.2)	450.1	565.6	855.2	535.6	689.8
SEP	R	824.4	407.0	650.2	826.0	512.9	619.2	842.8	508.0	632.3	989.2	615.4	783.6
	T	731.5	365.6	593.3	769.7	480.2	582.2	738.8	422.7	590.6	851.3	541.2	733.1
OCT	R	809.5	12.1*	446.9	891.0	527.5	717.8	863.6	480.1	742.0	897.5	641.8	780.4
	T	723.1	NIL*	399.3	786.7	482.4	660.6	805.7	394.1	675.7	784.3	564.1	737.2
NOV	R	987.6	605.3	745.1	776.0	589.1	711.4	793.8	586.9	707.7	802.5	663.5	758.2
	T	903.5	549.1	677.5	717.5	531.7	656.3	712.6	510.3	647.3	728.4	595.2	697.5
DEC	R	977.5	486.3	722.5	782.1	535.3	685.8	735.8	438.4	663.6	809.7	552.5	723.3
	T	907.5	431.3	667.2	724.8	557.1	640.8	702.3	375.2	527.0	722.3	489.3	671.8

Note: Brackets indicate maximum day for the year.
The maximum or minimum raw and treated flows do not necessarily occur on the same day.
* Trial shutdown of plant
Data obtained from Department of Works - Water Supply Division Summary. (daily & monthly)

WPOS - R.C. HARRIS WTP

			1986			1985			1984			1983		
			MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	Turbidity (FTU)	R	5.8	0.4	1.2	17.0	0.4	1.56	7.0	0.5	1.01	18.0	0.4	2.1
		T	0.48	0.09	0.22	0.31	0.05	0.14	0.85	0.09	0.23	0.74	0.05	0.3
	Alum (mg/L)		7	3	3.2	7	3	3	5	3	3	3	3	3-(5)
	Ferric Chloride(1) (mg/L)											7	3	5-(6)
	Filter Aid (mg/L)													
	Metal Res. Al (mg/L)	R			0.015			0.022			0.015			0.053
		T	0.172	0.067	0.107	0.186	0.065	0.106	0.074	0.048	0.058	0.021	0.011	.014(2)
	pH	R	8.1	7.9	8.0	8.4	7.8	8.2	8.3	8.1	8.2	8.4	8.1	8.3
		T	7.6	7.4	7.5	7.7	7.4	7.6	7.7	7.6	7.7	7.7	7.5	7.6
	Temperature (°C)	R	4.0	1.0	2.9	4.0	1.5	2.8	4.0	0.5	2.4	4.0	1.0	2.8
FEB	Turbidity (FTU)	R	4.0	0.45	1.04	8.00	4.00	1.10	40.0	0.4	2.4	40.0	0.5	1.3
		T	0.30	0.08	0.16	0.38	0.05	0.14	0.75	0.1	0.3	0.86	0.08	0.3
	Alum (mg/L)		3	3	3	3	3	3	10.0	3.0	3.6-(7)			
	Ferric Chloride(1) (mg/L)											5.0	3.0	3.0-(4)
	Filter Aid (mg/L)													
	Metal Res. Al (mg/L)	R			0.067			0.015			0.015			0.050
		T	0.194	0.072	0.131	0.164	0.041	0.087	0.080	0.015	0.055	0.023	0.010	.015(2)
	pH	R	8.1	7.8	8.0	8.4	8.0	8.2	8.3	8.1	8.2	8.4	8.1	8.2
		T	7.6	7.3	7.5	7.7	7.5	7.6	7.7	7.6	7.7	7.8	7.5	7.7
	Temperature (°C)	R	2.5	0.0	1.4	3.0	1.0	2.0	3.0	1.5	2.5	3.0	0.5	1.7
MAR	Turbidity (FTU)	R	16	0.4	1.49	8.60	0.20	3.15	14.0	0.4	2.0	18	0.3	1.6
		T	0.47	0.10	0.18	0.35	0.08	0.19	0.42	0.12	0.18	0.87	0.05	0.3
	Alum (mg/L)		7	3	3.1	10	3	3	7	3	3.1			
	Ferric Chloride(1) (mg/L)											3	3	3-(3)
	Filter Aid (mg/L)													
	Metal Res. Al (mg/L)	R			0.071			0.040			0.015			0.030
		T	0.109	0.013	0.064	0.127	0.051	0.084	0.090	0.046	0.069	0.031	0.005	.016(2)
	pH	R	8.2	7.2	8.0	8.2	8.0	8.2	8.3	8.1	8.2	8.4	8.1	8.3
		T	7.6	7.1	7.4	7.6	7.5	7.5	7.7	7.6	7.7	7.8	7.3	7.8
	Temperature (°C)	R	3	1.5	2.1	4.0	2.0	2.5	3.0	1.0	1.8	4.0	2.0	2.8

Note: Data obtained from daily operation sheets and monthly summary sheets.

			1986			1985			1984			1983		
			MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
APR	Turbidity (FTU)	R	22.0	0.45	1.16	23.0	0.40	2.41	19.0	0.4	1.84	4.4	0.4	1.15
		T	0.30	0.13	0.19	0.48	0.11	0.19	0.65	0.05	0.20	0.82	0.12	0.37
	Alum (mg/L)		10	3	3	10	3	3	10	3	3.2			
	Ferric Chloride(1) (mg/L)											8	2	3.0
	Filter Aid (mg/L)													
	Metal Res. Al (mg/L)	R			0.111			0.137(8)			0.017(8)			0.016
		T	0.120	0.024	0.062	0.220	0.068	0.111	0.130	0.050	0.078	0.033	0.013	.022(2)
	pH	R	8.6	8.0	8.2	8.4	8.0	8.0	8.4	8.2	8.2	8.4	8.0	8.3
		T	7.5	7.0	7.3	7.8	7.5	7.6	7.9	7.6	7.8	7.8	7.6	7.7
	Temperature (°C)	R	6.0	2.5	3.6	6.0	2.5	3.8	5.5	2.0	3.5	5.0	3.0	3.8
MAY	Turbidity (FTU)	R	1.60	0.45	0.81	1.60	0.20	0.78	26.0	0.4	1.18	2.0	0.4	0.85
		T	0.49	0.14	0.26	0.50	0.10	0.26	0.5	0.11	0.24	0.83	0.11	0.35
	Alum (mg/L)		5	3	3	3	3	3	10	2	3.1	5	5	5(10)
	Ferric Chloride(1) (mg/L)											3	2	2.1(11)
	Filter Aid (mg/L)													
	Metal Res. Al (mg/L)	R			0.280			0.016						
		T	0.140	0.032	0.089	0.317	0.097	0.186	0.112	0.066	0.093	0.026	0.010	.020(2)
	pH	R	8.6	8.0	8.3	8.5	8.0	8.3	8.4	8.2	8.3	8.5	8.2	8.3
		T	7.5	7.2	7.4	7.7	7.3	7.6	7.8	7.4	7.6	7.9	7.6	7.8
	Temperature (°C)	R	9.5	3.5	6.0	10.0	4.0	6.0	6.5	4.0	5.4	8.0	4.5	6.3
JUN	Turbidity (FTU)	R	1.8	0.40	0.66	1.80	0.40	0.71	1.6	0.5	0.87	6.0	0.4	0.95
		T	0.52	0.12	0.22	0.42	0.07	0.22	0.6	0.1	0.26	0.9	0.08	0.39-(9)
	Alum (mg/L)		5	3	3	3	3	3	5	2	2.8	5	5	5
	Ferric Chloride (mg/L)											.		
	Filter Aid (mg/L)													
	Metal Res. Al (mg/L)	R			0.270			0.017			0.015(8)			.010(8)
		T	0.220	0.095	0.111	0.144	0.065	0.104	0.248	0.152	0.193	0.245	0.010	0.122
	pH	R	8.8	7.8	8.2	8.4	7.5	8.4	8.3	8.2	8.2	8.5	8.1	8.4
		T	7.4	7.1	7.2	7.6	7.1	7.6	7.7	7.6	7.6	8.1	7.4	7.8
	Temperature (°C)	R	11.0	4.5	7.0	7.5	4.5	5.8	14.0	5.0	6.5	10	5	6.7

Note: Data obtained from daily operation sheets and monthly summary sheets.

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JUL	Turbidity (FTU)		R	12.0	0.40	0.83	1.40	0.50	0.82	1.6	0.4	0.77	4.7	0.4	0.8
			T	0.57	0.13	0.25	0.49	0.15	0.27	0.68	0.08	0.20	0.72	0.12	0.34
	Alum	(mg/L)		7	3	3	5	3	3	5	3	3	5	5	5
	Ferric Chloride	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.063(8)			0.015			0.055(8)			.020(8)
			T	0.173	0.045	0.097	0.163	0.065	0.107	0.200	0.110	0.147	0.164	0.026	0.094
	pH		R	8.5	7.6	8.2	8.5	7.4	8.2	8.6	8.1	8.2	8.5	8.0	8.2
			T	7.4	7.1	7.3	7.7	7.4	7.6	7.7	7.5	7.6	7.8	7.4	7.6
	Temperature	(°C)	R	18.0	4.5	10.5	17.5	5.0	7.6	16.5	5.0	6.8	14.0	5.0	8.2
AUG	Turbidity (FTU)		R	5.40	0.35	1.1	3.70	0.60	1.06	6.8	0.5	1.15	12.5	0.6	1.6
			T	0.47	0.10	0.19	0.58	0.12	0.28	0.71	0.09	0.24	1.0	0.13	0.34
	Alum	(mg/L)		7	3	3	7	3	4.3	7	3	3.3	7	5	5-(14)
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.083			0.015			0.020(8)			.015(8)
			T	0.132	0.030	0.074	0.240	0.093	0.154	0.300	0.200	0.261	0.395	0.060	0.176
	pH		R	8.4	7.6	7.9	8.9	7.9	8.2	8.5	7.9	8.1	8.6	80	82
			T	7.3	7.0	7.2	7.6	7.2	7.4	7.7	7.3	7.5	7.6	7.4	7.5
	Temperature	(°C)	R	21.5	5.0	11.7	21.0	8.0	16.8	23.0	6.5	13.6	22.0	6.0	16.4
SEP	Turbidity (FTU)		R	3.4	0.50	1.2	5.4	0.40	0.93	9.0	0.4	1.21	3.8	0.5	0.99
			T	0.51	0.11	0.2	0.50	0.08	0.27	0.63	0.08	0.21	0.8	0.14	0.36
	Alum	(mg/L)		5	3	3	7	3	3.7	7	3	3.4	5	5	5.0(13)
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.028			0.073			0.020(8)			0-(8)
			T	0.158	0.026	0.066	0.253	0.061	0.134	0.325	0.200	0.243	0.200	0.062	0.112
	pH		R	8.4	7.3	8.0	8.9	7.9	8.2	8.4	8.0	8.1	8.2	7.9	8.0
			T	7.4	7.1	7.2	7.4	7.1	7.3	7.7	7.5	7.6	7.7	7.5	7.6
	Temperature	(°C)	R	17.0	5.0	11.2	22.0	6.0	16.5	20.0	5.0	11.4	22.0	5.0	10.6

Note: Data obtained from daily operation sheets and monthly summary sheets.

TABLE 2.0 (cont'd.)

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
OCT	Turbidity (FTU)		R	19.0	0.52	1.4	1.30	0.30	0.58	2.8	0.5	0.77	3.0	0.4	0.79
			T	0.48	0.12	0.22	0.46	0.08	0.18	0.72	0.1	0.24	0.8	0.08	0.28
	Alum	(mg/L)		7	3	3.8	3	3	3	7	3	3.1	5	5	5-(17)
	Ferric Chloride	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.017(8)			0.073			0.022(8)			-(8)
			T				0.200	0.065	0.155	0.280	0.100	0.204	0.296	0.032	0.145
	pH		R	8.5	7.8	8.0	8.4	8.0	8.2	8.4	8.0	8.2	8.3	8.1	8.2
			T	7.5	7.1	7.3	7.5	7.1	7.3	7.9	7.5	7.7	7.7	7.5	7.6
	Temperature	(°C)	R	16.5	5.0	9.0	14.5	5.0	9.2	14.0	6.0	10.8	16.0	5.0	10.5
NOV	Turbidity (FTU)		R	11.0	0.62	1.4	9.2	0.45	1.40	2.4	0.4	0.78	12	0.4	1.32
			T	0.36	0.12	0.20	0.75	0.12	0.20	0.48	0.05	0.17	0.32	0.07	0.16
	Alum	(mg/L)		7	3	3.1	5	3	3	3	3	3	7	3	3.50
	Ferric Chloride	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R						0.058(8)			0.023(8)			
			T				0.279	0.040	0.141			0.190	0.259	0	0.206
	pH		R	8.3	7.8	7.9	8.8	7.4	8.1	8.5	7.6	8.1	8.3	8.1	8.2
			T	7.5	7.2	7.3	7.5	7.3	7.4	7.7	7.3	7.6	7.6	7.5	7.6
	Temperature	(°C)	R	10.0	4.5	6.5	12.5	5.5	9.2	13.0	4.5	7.4	8.5	6.0	7.4
DEC	Turbidity (FTU)		R	38.0	0.85	3.4	4.00	0.40	1.20	30.0	0.5	2.2	17.0	0.5	1.7
			T	0.36	0.12	0.20	0.62	0.10	0.17	0.3	0.06	0.1	0.82	0.08	0.2
	Alum	(mg/L)		10	3	3.4	5	3	3	10	3	3.3	7	3	3.7(16)
	Ferric Chloride	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.013			0.010						0.041(8)
			T	0.180	0.033	0.076	0.138	0.057	0.083				0.263	0.033	0.086
	pH		R	8.4	7.8	8.0	8.2	7.8	8.1	8.3	8.0	8.1	8.3	8.1	8.2
			T	7.5	7.1	7.3	7.6	7.2	7.5	7.7	7.3	7.6	7.7	7.5	7.6
	Temperature	(°C)	R	5.0	3.0	4.2	7.5	3.5	5.2	5.5	3.0	4.5	6.5	4.0	4.2

Note: Data obtained from daily operation sheets and monthly summary sheets.

(1) Ferric Chloride used as prime coagulant Jan. 17-31, Feb., Mar., Apr., May 1-15, 1983. Alum used at all other times. Iron (Fe) residuals are displayed for months that Ferric Chloride was used as prime coagulant, otherwise Aluminum (Al) residuals displayed.

(2) Iron (Fe) residuals.

(3) Ferric chloride process out for 50% of the time.

(4) Ferric chloride process out for 60% of the time.

(5) Ferric chloride used as prime coagulant Jan. 17-31, out Jan. 26 and 27.

(6) Alum used as prime coagulant Jan. 1-16; switched midday on 17th to ferric chloride.

(7) Alum out Feb. 1-7, 9-12, 1984.

(8) Total metal residual, all others are filtered metal residuals.

(9) Alum out 70% of the time between June 1st and 8th, 1983.

(10) Alum out 70% of the time between May 16-31, 1983.

(11) Ferric chloride out 78% of the time between May 1st and 13th, 1983.

(12) Ferric chloride out 65% of the time during April, 1983.

(13) Alum feed out majority of month, Sept/83.

(14) Alum feed out 50% of the time, Aug./83.

(15) Alum feed out 60% of the time, July/83.

(16) Alum feed out Dec. 6-18/83.

(17) Alum feed out Oct. 1-21/83.

TABLE 2.1: PARTICULATE REMOVAL PROFILE (APR/1986)

WPOS - R.C. HARRIS WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP. (^{O}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	1.38	1.45	0.22	0.20	3			0.111(1)	0.027	8.1	7.3	3.0
2	1.11	1.21	0.21	0.19	3				0.120	8.2	7.3	3.0
3	1.70	1.70	0.18	0.20	3				0.092	8.2	7.3	3.8
4	1.10	1.05	0.16	0.17	3				0.067	8.2	7.3	3.0
5	1.58	1.36	0.21	0.22	3				0.035	8.2		3.6
6	7.46	2.22	0.22	0.23	4.7				0.039	8.2		3.8
7	1.44	1.89	0.24	0.24	3				0.068	8.2	7.3	4.2
8	1.40	1.50	0.16	0.17	3				0.048	8.2	7.3	4.1
9	0.65	0.83	0.16	0.18	3				0.036	8.2	7.4	3.0
10	0.69	0.63	0.17	0.17	3				0.048	8.2	7.5	3.0
11	0.51	0.66	0.20	0.18	3				0.054	8.2	7.3	2.5
12	0.75	0.76	0.15	0.15	3				0.032	8.2		2.8
13	0.91	1.25	0.16	0.16	3				0.024	8.2		3.0
14	1.00	0.92	0.15	0.15	3				0.038	8.2	7.5	3.4
15	1.30	1.40	0.18	0.17	3				0.065	8.2	7.4	3.8

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	1.10	1.30	0.20	0.20	3				0.035	8.2	7.1	3.8
17	0.79	1.23	0.21	0.21	3				0.029	8.2	7.5	3.4
18	0.63	0.80	0.19	0.19	3				0.057	8.2	7.3	3.5
19	0.74	0.87	0.20	0.18	3				0.095	8.2		3.8
20	0.66	0.75	0.16	0.16	3				0.096	8.2		3.6
21	0.53	0.86	0.16	0.16	3				0.081	8.2	7.4	3.5
22	0.66	0.80	0.17	0.17	3				0.089	8.2	7.3	3.4
23	0.82	0.91	0.19	0.18	3				0.065	8.2	7.5	3.2
24	1.01	1.30	0.23	0.20	3				0.110	8.0	7.1	3.5
25	0.60	0.93	0.21	0.20	3				0.066	8.0	7.1	3.0
26	0.56	0.80	0.18	0.17	3				0.067	8.0		3.3
27	1.00	1.20	0.24	0.22	3				0.051	8.0		4.3
28	0.99	1.20	0.27	0.25	3				0.057	8.2	7.0	5.1
29	0.79	1.13	0.22	0.21	3				0.093	8.3	7.1	4.5
30	0.88	1.20	0.20	0.21	3				0.079	8.3	7.3	4.6

(1) Total metal residual done on raw water once per month.
(2) Treated water aluminum residuals are filtered residuals; i.e. sample has been filtered prior to analysis.

Note: Data obtained from daily operating sheets.

TABLE 2.2: PARTICULATE REMOVAL PROFILE (APR/1985)

WPOS - R.C. HARRIS WTP

DATE	TURBIDITY (FTU)				COAGULANT ALUM	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	9.00	2.50	0.16	0.16	5.7				0.091(2)	8.2	7.6	3.0
2	2.00	1.20	0.16	0.17	3			0.137(1)	0.079	8.1	7.6	2.5
3	0.75	0.78	0.12	0.16	3				0.068	8.2	7.7	2.5
4	0.67	0.79	0.13	0.13	3				0.151	8.2	7.6	2.5
5	7.60	2.50	0.14	0.15	5				0.109	8.2		3.0
6	4.20	2.50	0.15	0.16	4				0.083	8.2		2.9
7	8.60	3.90	0.24	0.19	5.3				0.102	8.2		3.2
8	3.10	2.70	0.26	0.27	3				0.106	8.1		3.0
9	2.00	1.90	0.15	0.15	3				0.083	8.2	7.6	3.0
10	1.70	1.60	0.14	0.18	3				0.079	8.2	7.6	3.0
11	3.30	2.50	0.18	0.13	3				0.079	8.2	7.6	3.1
12	1.90	1.90	0.21	0.20	3				0.121	8.1	7.6	3.0
13	2.50	2.10	0.17	0.15	3				0.075	8.1		3.3
14	4.10	3.00	0.18	0.16	3.8				0.068	8.1		3.5
15	4.00	2.80	0.17	0.17	4.2				0.109	8.1	7.5	4.0

TABLE 2.2 (APR/85) (cont'd.)

DATE	TURBIDITY (FTU)				COAGULANT ALUM	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	2.00	1.80	0.16	0.18	3				0.094	8.2	7.6	4.0
17	1.20	1.20	0.13	0.16	3				0.113	8.2	7.6	3.5
18	1.30	1.30	0.17	0.14	3				0.069	8.2	7.7	3.5
19	1.60	1.60	0.21	0.19	3				0.102	8.2	7.7	4.0
20	1.00	1.40	0.22	0.19	3				0.078	8.2		4.3
21	0.74	1.30	0.17	0.19	3				0.065	8.2		4.3
22	0.73	1.20	0.15	0.16	3				0.110	8.3	7.7	4.5
23	0.95	1.10	0.18	0.16	3				0.094	8.3	7.7	4.8
24	0.89	1.20	0.22	0.21	3				0.131	8.3	7.8	5.0
25	0.91	1.20	0.25	0.25	3				0.100	8.3	7.7	5.1
26	1.30	1.40	0.25	0.27	3				0.190	8.3	7.6	5.0
27	1.50	1.40	0.33	0.30	3				0.200	8.4		6.0
28	1.20	1.20	0.21	0.24	3				0.157	8.4		5.1
29	0.94	1.00	0.26	0.24	3				0.220	8.4	7.7	5.3
30	0.66	0.83	0.23	0.28	3				0.200	8.2	7.7	4.3

Note: (1) Total metal residual done on raw water once per month.
Treated water aluminum residuals are filtered residuals, i.e. sample has been filtered prior to analysis.

TABLE 3.0: DISINFECTION SUMMARY

WPOS - R.C. HARRIS WTP

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	2.5	0.35	0.9	0.8	0.8	0.8	3.50	0.30	0.74
	Ammonia Dosage				0.2	0.2	0.2			(1)	0.2	0.2	0.2
	SO_2 Dosage				2.1		0.45				2.8		0.27
	Resid. Cl_2 Free	2.8	0.60	1.09	0.80	0.40	0.60	3.6	0.55	0.89	0.96	0.30	0.58
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.0	0.60	0.77				1.2	0.53	0.78
FEB	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	3.0	0.2	0.82	0.8	0.8	0.8	4.2	0.30	0.78
	Ammonia Dosage			(2)	0.2	0.2	0.2				0.2	0.2	0.2
	SO_2 Dosage				2.5		0.45				2.6		0.29
	Resid. Cl_2 Free	3.1	0.65	1.00	0.72	0.24	0.53	3.0	0.54	0.94	0.84	0.36	0.60
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.1	0.48	0.66				1.2	0.54	0.79
MAR	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	6.8	0.3	1.5	0.8	0.8	0.8	4.0	0.35	1.5
	Ammonia Dosage			(2)						(3)	0.2	0.2	0.2
	SO_2 Dosage				3.5		0.95				2.7		0.72
	Resid. Cl_2 Free	3.4	0.63	1.54	1.1	0.28	0.51	3.2	0.55	1.41	1.4	0.3	0.56
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.1	0.40	0.65				1.3	0.50	0.80

NOTE: The free chlorine residuals listed under pre-chlorination are taken following pre and post chlorination, prior to de-chlorination, (before SO_2 sampling point). The post-chlorination residuals are taken after de-chlorination. Only average and maximum SO_2 dosages are recorded at the R.C. Harris Plant.

Data obtained from monthly summary sheets.

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
APR	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	10.0	0.35	1.8	0.8	0.8	0.8	2.8	0.3	0.71
	Ammonia Dosage			(2)							0.2	0.17	0.17
	SO_2 Dosage				4.2		1.0				2.1		0.28
	Resid. Cl_2 Free	3.9	0.60	1.59	1.1	0.32	0.51	2.8	0.40	0.85	0.94	0.20	0.52
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.3	0.40	0.69				1.2	0.38	0.70
MAY	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	3.0	0.50	1.8	0.8	0.8	0.8	3.80	0.40	1.0
	Ammonia Dosage			(2)							0.17	0.17	0.17
	SO_2 Dosage				2.5		1.2				3.4		0.43
	Resid. Cl_2 Free	2.8	0.65	1.77	1.2	0.30	0.51	3.5	0.5	1.0	1.0	0.20	0.51
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.2	0.36	0.67				1.4	0.34	0.73
JUN	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	4.0	0.6	2.0	1.4	0.5	0.8	4.5	0.40	1.1
	Ammonia Dosage			(2)							0.17	0.17	0.17
	SO_2 Dosage				2.2		1.4				2.8		0.57
	Resid. Cl_2 Free	2.8	0.80	1.86	0.80	0.25	0.50	3.8	0.65	1.16	1.4	0.27	0.51
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.0	0.34	0.66				1.3	0.56	0.73

NOTE: The free chlorine residuals listed under pre-chlorination are taken following pre and post chlorination, prior to de-chlorination, (before SO_2 sampling point). The post-chlorination residuals are taken after de-chlorination. Only average and maximum SO_2 dosages are recorded at the R.C. Harris Plant.

Data obtained from monthly summary sheets.

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JUL	Cl_2 Demand	0.8	0.8	0.8	2.3	0.6	1.9	0.8	0.8	0.8	2.50	0.50	0.77
	Cl_2 Dosage												
	Ammonia Dosage			(2)							0.20	0.17	0.17
	SO_2 Dosage				1.7		1.2				2.3		0.17
	Resid. Cl_2 Free	2.2	0.65	1.68	0.90	0.30	0.51	2.8	0.50	0.70	0.86	0.35	0.50
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.1	0.48	0.67				0.90	0.56	0.70
AUG	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	2.8	2.0	2.0	0.8	0.8	0.8	2.80	0.70	1.6
	Ammonia Dosage			(2)							0.17	NIL	0.17
	SO_2 Dosage				1.8		1.3				2.4		0.71
	Resid. Cl_2 Free	2.4	1.0	1.74	0.92	0.32	0.51	2.90	0.30	1.36	0.80	0.24	0.51
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.0	0.46	0.69				0.98	0.34	0.74
SEP	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	5	2	2.1	0.8	0.8	0.8	3.0	2.0	2.2
	Ammonia Dosage			(2)							0.17	0.17	0.17
	SO_2 Dosage				3.0		1.4				2.1		1.4
	Resid. Cl_2 Free	3.0	1.5	1.97	1.0	0.30	0.51	2.6	1.7	2.06	2.0	0.16	0.52
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.2	0.40	0.67				2.0	0.38	0.72

NOTE: The free chlorine residuals listed under pre-chlorination are taken following pre and post chlorination, prior to de-chlorination, (before SO_2 sampling point). The post-chlorination residuals are taken after de chlorination. Only average and maximum SO_2 dosages are recorded at the R.C. Harris Plant.

Data obtained from monthly summary sheets.

TABLE 3.0 (cont'd.)

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
OCT	Cl_2 Demand												
	Cl_2 Dosage (mg/L)	0.8	0.8	0.8	3.8	1.5	2.2	0.8	0.8	0.8	9.0	0.40	1.7
	Ammonia Dosage			(2)	0.22	0.05	0.16				0.20	0.17	0.19(4)
	SO_2 Dosage				3.0		1.4				3.0		1.1
	Resid. Cl_2 Free	3.0	1.4	2.02	1.1	0.30	0.56	3.6	0.60	1.66	1.0	0.30	0.56
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.0	0.32	0.73				1.3	0.40	0.74
NOV	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	3.8	0.7	2.0	0.8	0.8	0.8	3.7	0.35	1.9
	Ammonia Dosage			(2)	0.25	0.07	0.17				0.2	0.2	0.2
	SO_2 Dosage				2.7		1.3				2.1		1.2
	Resid. Cl_2 Free	2.8	0.75	1.87	0.80	0.40	0.59	2.5	0.55	1.89	1.0	0.20	0.60
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.95	0.55	0.74				1.0	0.32	0.76
DEC	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	7.0	0.6	1.8	0.8	0.8	0.8	5.0	0.35	1.1
	Ammonia Dosage				0.24	0.06	0.18				0.2	0.2	0.2(5)
	SO_2 Dosage				3.0		1.0				2.6		0.55
	Resid. Cl_2 Free	3.7	0.75	1.66	0.80	0.38	0.59	3.0	0.60	1.17	0.90	0.30	0.57
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.95	0.55	0.75				1.3	0.38	0.74

NOTE: The free chlorine residuals listed under pre-chlorination are taken following pre and post chlorination, prior to de-chlorination, (before SO_2 sampling point). The post-chlorination residuals are taken after de-chlorination. Only average and maximum SO_2 dosages are recorded at the R.C. Harris Plant.

Data obtained from monthly summary sheets.

NOTES: TABLE 3.0

(1) Ammonia system out Jan. 9-10/85.

(2) Ammonia system out for Feb. - Nov. 1986.

(3) Ammonia system out Mar./85.

(4) Ammonia out Oct. 17 - 27/85.

(5) Ammonia out Dec. 7 - Dec.17/85.

WPOS - R.C. HARRIS WTP

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	Cl_2 Demand	1.0	0.5	0.81	3.5	0.2	0.78	1.0	0.5	0.7	5.0	0.3	1.2
	Cl_2 Dosage												
	Ammonia Dosage				0.2	0.2	0.2(3)				0.2	0.15	0.2
	SO_2 Dosage				2.6		0.29				4.0		0.59
	Resid. Cl_2 Free	2.5	0.60	0.92	1.6	0.34	0.60	2.8	0.40	1.12	1.1	0.20	0.54
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.7	0.50	0.81				1.4	4.6	0.77
FEB	Cl_2 Demand												
	Cl_2 Dosage	0.5	0.5	0.5	6.7	0.5	1.1	0.5	0.5	0.5	4.0	0.5	1.1
	Ammonia Dosage				0.2	0.2	0.2				0.2	0.2	0.2
	SO_2 Dosage				5.5		0.36				2.8		0.35
	Resid. Cl_2 Free	4.0	0.50	0.96	1.6	0.20	0.57	2.6	0.45	0.97	0.90	0.30	0.60
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.7	0.30	0.77				1.3	0.50	0.85
MAR	Cl_2 Demand												
	Cl_2 Dosage	0.5	0.5	0.5	3.8	0.55	0.95	0.5	0.5	0.5	7.0	0.5	1.3
	Ammonia Dosage				0.2	0.17	0.17				0.2	0.2	0.2(1)
	SO_2 Dosage				3.2		0.32				3.2		0.41
	Resid. Cl_2 Free	4.0	0.50	0.94	1.4	0.20	0.51	4.0	0.55	1.02	0.84	0.30	0.60
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.4	0.23	0.71				1.3	0.50	0.85

NOTE: The free chlorine residuals listed under pre-chlorination are taken following pre and post chlorination, prior to de-chlorination, (before SO_2 sampling point). The post-chlorination residuals are taken after de-chlorination. Only average and maximum SO_2 dosages are recorded at the R.C. Harris Plant. Data obtained from monthly summary sheets.

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
APR	Cl_2 Demand												
	Cl_2 Dosage	0.5	0.5	0.5	3.0	0.5	0.79	0.5	0.5	0.5	3.6	0.55	1.0
	Ammonia Dosage				0.17	0.17	0.17				0.2	0.2	0.2(6)
	SO_2 Dosage				2.4		0.22				1.9		0.26
	Resid. Cl_2 Free	3.0	0.50	0.79	0.90	0.20	0.51	2.0	0.45	0.93	1.1	0.30	0.59
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.1	0.46	0.71				1.3	0.52	0.83
MAY	Cl_2 Demand												
	Cl_2 Dosage	0.5	0.5	0.5	2.6	0.5	0.94	0.5	0.5	0.5	4.2	0.5	1.1
	Ammonia Dosage				0.17	0.17	0.17				0.5	0.15	0.2(5)
	SO_2 Dosage				2.1		0.32				2.0		0.28
	Resid. Cl_2 Free	2.8	0.40	0.87	1.0	0.22	0.51	2.5	0.60	0.98	1.0	0.32	0.61
	Resid. Cl_2 Comb.				-	-	-				-	-	-
	Resid. Cl_2 Total				1.3	0.40	0.71				1.3	0.56	0.82
JUN	Cl_2 Demand												
	Cl_2 Dosage	0.5	0.5	0.5	4.0	0.45	1.3	1.0	0.5	0.51	2.8	0.5	1.1
	Ammonia Dosage				0.17	0.17	0.17(8)				0.2	0.17	0.2(1)
	SO_2 Dosage				2.2		0.44				2.0		0.27
	Resid. Cl_2 Free	3.6	0.45	1.05	1.6	0.20	0.51	1.9	0.50	0.92	1.0	0.27	0.57
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.9	0.50	0.72				1.2	0.48	0.80

NOTE: The free chlorine residuals listed under pre-chlorination are taken following pre and post chlorination, prior to de-chlorination, (before SO_2 sampling point). The post-chlorination residuals are taken after de-chlorination. Only average and maximum SO_2 dosages are recorded at the R.C. Harris Plant. Data obtained from monthly summary sheets.

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JUL	Cl_2 Demand												
	Cl_2 Dosage	1.5	0.5	0.61	2.5	0.3	0.95	1.0	0.5	1.0	2.5	0.4	1.2
	Ammonia Dosage				0.17	0.17	0.17(14)				0.17	0.17	0.17(11)
	SO_2 Dosage				1.8		0.31				2.2		0.62
	Resid. Cl_2 Free	2.4	0.45	0.89	0.80	0.20	0.50	2.8	0.50	1.22	0.83	0.34	0.51
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.0	0.40	0.69				1.0	0.45	0.74
AUG	Cl_2 Demand												
	Cl_2 Dosage	1.5	0.5	0.84	3.0	0.55	1.6	1.0	1.0	1.0	2.6	0.8	1.5
	Ammonia Dosage				0.17	0.17	0.17(13)				0.17	0.17	0.17(10)
	SO_2 Dosage				2.2		0.74				2.0		0.79
	Resid. Cl_2 Free	2.4	0.50	1.33	1.2	0.20	0.50	2.2	0.70	1.38	0.94	0.20	0.53
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.2	0.38	0.77				1.1	0.30	0.78
SEP	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.5	0.71	4.0	0.5	0.97	1.0	1.0	1.0	2.4	0.6	0.97
	Ammonia Dosage				0.17	0.17	0.17(12)				0.17	0.17	0.17(9)
	SO_2 Dosage				2.0		0.30				2.2		0.56
	Resid. Cl_2 Free	2.7	0.50	0.91	1.1	0.24	0.50	2.7	0.80	1.18	1.1	0.21	0.52
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.3	0.30	0.70				1.2	0.29	0.74

NOTE: The free chlorine residuals listed under pre-chlorination are taken following pre and post chlorination, prior to de-chlorination, (before SO_2 sampling point). The post-chlorination residuals are taken after de chlorination. Only average and maximum SO_2 dosages are recorded at the R.C. Harris Plant.

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
OCT	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	2.7	0.45	0.96	1.0	1.0	1.0	3.7	0.55	0.94
	Ammonia Dosage				0.2	0.2	0.2				0.2	0.17	0.16(17)
	SO_2 Dosage				1.8		0.27				2.8		0.54
	Resid. Cl_2 Free	2.9	0.55	0.96	1.1	0.30	0.59	2.5	0.80	1.17	0.86	0.30	0.55
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				1.4	0.55	0.82				1.1	0.43	0.75
NOV	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	6.0	0.35	0.94	1.0	1.0	1.0	3.0	0.55	0.82
	Ammonia Dosage				0.2	0.2	0.2(18)				0.2	0.2	0.2(16)
	SO_2 Dosage				6.5		0.33				2.2		0.48
	Resid. Cl_2 Free	5.5	0.60	0.99	1.7	0.14	0.58	2.3	0.65	1.14	1.5	0.30	0.61
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				2.0	0.14	0.80				1.5	0.30	0.80
DEC	Cl_2 Demand												
	Cl_2 Dosage	0.8	0.8	0.8	5.5	0.4	0.82	1.0	0.5	0.77	2.0	0.3	0.82
	Ammonia Dosage				0.2	0.2	0.2				0.2	0.2	0.2(15)
	SO_2 Dosage				3.5		0.28				1.7		0.33
	Resid. Cl_2 Free	3.5	0.30	0.93	1.3	0.30	0.60	2.2	0.45	0.97	1.3	0.20	0.60
	Resid. Cl_2 Comb.				-								
	Resid. Cl_2 Total				1.4	0.40	0.79				1.8	0.40	0.79

NOTE: The free chlorine residuals listed under pre-chlorination are taken following pre and post chlorination, prior to de-chlorination, (before SO_2 sampling point). The post-chlorination residuals are taken after de-chlorination. Only average and maximum SO_2 dosages are recorded at the R.C. Harris Plant. Data obtained from monthly summary sheets.

NOTES: TABLE 3.1

(1) Ammoniation out Mar. 2, 17, 28-31, 1983.

(2) Ammoniation out Feb. 4, 5, 8-13, 1984.

(3) Ammoniation out Jan. 29, 30, 1984.

(4) Ammoniation out June 1, 1983.

(5) Ammoniation out May 31, 1983.

(6) Ammoniation out April 1-5, 1983.

(7) Ammoniation out April 18-25, 1984.

(8) Ammoniation out June 16-18, 24, 30, 1984.

(9) Ammoniation out Sept. 10-14, 1983.

(10) Ammoniation out Aug. 1-3, 1983.

(11) Ammoniation out July 28-31, 1983.

(12) Ammoniation out Sept. 30, 1984.

(13) Ammoniation out Aug. 7-13, 23-27, 1984.

(14) Ammoniation out July 1, 1984.

(15) Ammoniation out Dec. 2-8, 1983.

(16) Ammoniation out Nov. 1, 1983.

(17) Ammoniation out Oct. 5-11, 1983.

(18) Ammoniation out Nov. 1-6, 1984.

TABLE 3.2: DISINFECTION PROFILE (JULY/86)

WPOS - R.C. HARRIS WTP

DATE	PRE-CHLORINATION							POST-CHLORINATION						
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
1		0.8			1.86				2.0		1.4	0.48		0.64
2		0.8			1.89				2.0		1.5	0.51		0.65
3		0.8			1.93				2.0		1.4	0.52		0.65
4		0.8			1.91				2.0		1.6	0.48		0.66
5		0.8			1.86				1.9		1.7	0.50		0.70
6		0.8			0.78				0.6		1.3	0.46		0.64
7		0.8			1.11				1.2		1.4	0.50		0.67
8		0.8			1.30				1.1		1.5	0.50		0.69
9		0.8			1.41				1.6		1.7	0.51		0.71
10		0.8			1.88				2.0		1.5	0.49		0.65
11		0.8			1.69				2.0		1.5	0.51		0.62
12		0.8			1.78				2.0		1.6	0.51		0.62
13		0.8			1.79				2.0		1.4	0.51		0.61
14		0.8			1.81				2.0		1.4	0.53		0.63
15		0.8			1.86				2.0		1.3	0.50		0.61

DATE	PRE-CHLORINATION							POST-CHLORINATION						
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
16		0.8			1.76				2.0		1.4	0.48		0.61
17		0.8			1.73				2.0		1.6	0.48		0.61
18		0.8			1.79				2.0		1.6	0.50		0.71
19		0.8			1.73				2.0		1.5	0.51		0.70
20		0.8			1.64				2.0		1.4	0.51		0.70
21		0.8			1.78				2.0		1.3	0.49		0.64
22		0.8			1.64				2.0		1.3	0.50		0.69
23		0.8			1.67				2.0		1.6	0.51		0.66
24		0.8			1.79				2.1		1.5	0.52		0.70
25		0.8			1.61				2.0		1.6	0.52		0.77
26		0.8			1.68				2.0		1.5	0.49		0.74
27		0.8			1.78				2.0		1.5	0.53		0.70
28		0.8			1.73				2.0		1.3	0.55		0.69
29		0.8			1.67				2.0		1.2	0.50		0.67
30		0.8			1.68				2.0		1.6	0.55		0.70
31		0.8			1.60				2.0		1.7	0.52		0.72

Note: The free chlorine residuals listed under pre-chlorination are taken immediately prior to dechlorination. The free chlorine residual measurements listed under post-chlorination are taken immediately after dechlorination. The total chlorine residuals listed under post-chlorination are taken after dechlorination and prior to the water leaving the plant.

Data obtained from daily operating sheets.

TABLE 3.3: DISINFECTION PROFILE (AUG./86)

WPOS - R.C. HARRIS WTP

DATE	PRE-CHLORINATION							POST-CHLORINATION						
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
1		0.8			1.78				2.2		1.6	0.54		0.71
2		0.8			1.60				2.0		1.5	0.51		0.64
3		0.8			1.64				2.0		1.0	0.52		0.63
4		0.8			1.61				2.0		1.0	0.51		0.66
5		0.8			1.77				2.0		1.3	0.49		0.64
6		0.8			1.76				2.0		1.6	0.58		0.70
7		0.8			1.49				2.0		1.6	0.48		0.66
8		0.8			1.41				2.1		1.6	0.52		0.67
9		0.8			1.40				2.0		1.3	0.50		0.66
10		0.8			1.65				2.1		1.3	0.52		0.65
11		0.8			1.82				2.0		1.3	0.54		0.73
12		0.8			1.92				2.0		1.7	0.56		0.75
13		0.8			1.90				2.0		1.4	0.55		0.74
14		0.8			1.86				2.0		1.7	0.52		0.75
15		0.8			1.63				2.0		1.5	0.50		0.68

DATE	PRE-CHLORINATION							POST-CHLORINATION						
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
16		0.8			1.69				2.1	0		0.52		0.63
17		0.8			1.75				2.0	0		0.51		0.68
18		0.8			1.66				2.0	0		0.49		0.67
19		0.8			1.56				2.0	0		0.51		0.69
20		0.8			1.62				2.0	0		0.52		0.72
21		0.8			1.73				2.0	0		0.48		0.70
22		0.8			1.66				2.0	0		0.48		0.66
23		0.8			1.67				2.0	0		0.50		0.69
24		0.8			1.84				2.0	0		0.50		0.62
25		0.8			1.89				2.0	0		0.53		0.68
26		0.8			1.95				2.0	0		0.52		0.73
27		0.8			1.93				2.0	0		0.50		0.73
28		0.8			1.86				2.0	0		0.52		0.76
29		0.8			1.97				2.2	0		0.48		0.71
30		0.8			1.93				2.0	0		0.50		0.68
31		0.8			1.93				2.0	0		0.52		0.63

Note: The free chlorine residuals listed under pre-chlorination are taken immediately prior to dechlorination. The free chlorine residual measurements listed under post-chlorination are taken immediately after dechlorination. The total chlorine residuals listed under post-chlorination are taken after dechlorination and prior to the water leaving the plant.

Data obtained from daily operating sheets.

TABLE 4.0 T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION SUMMARY

WPOS - R.C. HARRIS WTP

		1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.10	0.90	1.01	1.05	0.97	1.02	0.82	0.63	0.78	0.95	0.61	0.75
	F Res.	1.3	0.2	1.15	1.3	0.18	1.16	1.1	0.9	1.00	1.1	0.8	0.97
FEB	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.06	0.95	1.01	1.05	1.01	1.03	0.82	0.75	0.78	0.80	0.65	0.76
	F Res.	1.3	1.1	1.22	1.3	1.1	1.24	1.1	1.0	1.0	1.0	0.8	0.89
MAR	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.07	0.92	1.01	1.05	0.98	1.01	0.83	0.76	0.78	0.85	0.71	0.77
	F Res.	1.3	1.0	1.23	1.3	1.2	1.25	1.1	0.6	0.99	1.0	0.8	0.91
APR	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.11	0.99	1.03	1.05	0.98	1.01	0.85	0.75	0.80	0.82	0.70	0.73
	F Res.	1.3	1.1	1.24	1.2	1.2	1.2	1.1	0.9	1.03	1.0	0.8	0.95
MAY	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.04	0.90	1.00	1.07	1.00	1.02	0.89	0.71	0.80	0.86	0.63	0.78
	F Res.	1.3	1.1	1.19	1.3	1.1	1.22	1.1	1.0	1.06	1.0	0.17	0.93
JUN	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.02	0.96	0.99	1.07	1.02	0.70	1.05	0.83	0.76	0.84	0.71	0.79
	F Res.	1.2	1.1	1.18	1.4	1.1	1.25	1.1	0.9	0.97	1.0	0.8	0.95

		1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JUL	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.10	0.94	1.02	1.12	1.01	1.06	1.00	0.69	0.90	0.86	0.73	0.79
	F Res.	1.4	1.1	1.24	1.3	1.1	1.28	1.4	0.8	1.12	1.1	0.9	1.00
AUG	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.01	0.96	0.99	1.10	0.98	1.03	1.01	0.94	0.98	0.94	0.76	0.83
	F Res.	1.2	1.1	1.19	1.3	0.8	1.22	1.3	0.13	1.00	1.1	0.8	1.01
SEP	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.04	0.94	0.99	1.06	0.99	1.04	1.15	0.80	0.89	0.85	0.65	0.74
	F Res.	1.3	1.1	1.18	1.3	1.1	1.23	1.1	0.13	0.61	1.0	0.6	0.89
OCT	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.08	0.98	1.02	1.06	0.96	1.02	1.04	0.85	0.94	0.93	0.70	0.82
	F Res.	1.3	0.2	1.08	1.3	1.1	1.22	1.3	0.8	1.10	1.1	0.6	0.97
NOV	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.04	0.93	0.97	1.09	1.00	1.04	1.05	0.92	0.96	0.86	0.76	0.80
	F Res.	1.2	0.8	1.10	1.4	1.1	1.3	1.3	1.1	1.16	1.1	0.9	1.01
DEC	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	1.15	0.98	1.07	1.08	1.0	1.03	1.08	1.0	1.04	0.88	0.71	0.81
	F Res.	1.3	1.1	1.22	1.3	1.0	1.22	1.3	1.2	1.22	1.1	0.5	1.00

Note: Units used in this table are mg/L. Data obtained from monthly summary sheets.

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE(JAN./1986)

WPOS - R.C. HARRIS WTP

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE	
						Dosage	Residual
1						1.00	1.2
2						1.00	1.3
3						1.01	1.2
4						0.99	1.2
5						1.00	1.2
6						1.01	1.3
7						1.04	1.3
8						1.07	1.2
9						1.10	1.3
10						1.07	1.3
11						1.07	1.3
12						1.06	1.3
13						1.04	1.3
14						1.10	0.6 *
15						-(1)	0.2 *

Note: (1) Illegible data.

* Fluoride system shut-down for maintenance.

Data obtained from daily summary sheets.

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE	
						Dosage	Residual
16						0.90	0.6 *
17						1.02	1.2
18						1.05	1.3
19						1.05	1.3
20						1.01	1.2
21						0.98	1.2
22						0.93	1.2
23						0.95	1.0
24						0.96	1.2
25						0.96	1.2
26						0.98	1.2
27						0.94	1.2
28						0.96	1.2
29						0.97	1.1
30						0.96	1.2
31						0.95	1.3

WPOS - R.C HARRIS WTP

GENERAL CHEMISTRY		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
GENERAL CHEMISTRY -(1)															
Alkalinity (mg/L)	R			93			90			91.3	99.8	96	97.7	0.2 (mg/L)	
	T			85			84			83.3	90.8	88	89.0		
Ammonium (Total) (mg/L)	R										0.102	0.01	0.04	0.002 (mg/L)	
	T										0.06	0.01	0.02		
Calcium (mg/L)	R			41			41			40.7	41.9	37.9	39.7	0.1 (mg/L)	
	T			41			41			40.4	41.4	38.4	39.9		
Chloride (mg/L)	R			27			26		25	26.4	25.8	23.0	24.1	0.2 (mg/L)	250 (mg/L)
	T			28			28		26	27.9	28.0	26.0	27.2		
Colour (HCU)	R	10	2	7	8	3	5	6	4	4.7	6	3	4.6	0.5 (TCU)	5 (TCU)
	T	3	1	1	2	1	1	1	1	1	2	1	1.2		
Conductivity (umho/cm)	R			322			330			332.7	329	313	320.7	0.01 (umho/cm)	
	T			327			336			337.4	334	318	326.8		
Field Chlorine (Combined)	R													0.1 (mg/L)	
	T										0.68	0.15	0.32		
Field Chlorine (Free)	R													0.1 (mg/L)	
	T										0.55	0.07	0.36		
Field Chlorine (Total)	R													0.1 (mg/L)	
	T										0.75	0.64	0.68		
Field pH	R										8.5	7.8	8.2	0.2	
	T										7.5	7.3	7.4		

Note: All information obtained from DWSP.

GENERAL CHEMISTRY (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Field Temperature (^{O}C)	R										17.0	2.5	10.1		
	T										16.5	3.0	9.8		
Field Turbidity (FTU)	R										1.0	0.65	0.89		1 (FTU)
	T										0.54	0.10	0.25		
Fluoride (mg/L)	R	0.18	0.10	0.13	0.14	-	0.12	0.16	0.10	0.13	0.16	0.12	0.14	0.01 (mg/L)	2.4 (mg/L)
	T	1.1	0.17	0.96	1.4	0.13	1.02	1.4	0.18	1.23	1.36	1.07	1.20		
Hardness (mg/L)	R			135			134			133.7	140.0	127.5	133.2	0.5 (mg/L)	
	T			133			132			132.6	138.5	129.0	133.8		
Magnesium (mg/L)	R			8.8			8.2			8.3	8.6	8.0	8.3	0.05 (mg/L)	[c]
	T			8.6			8.2			8.3	8.5	8.0	8.3		
Nitrate (mg/L)	R			0.556			0.492			0.413	0.440	0.285	0.350	0.05 (mg/L)	10 (mg/L as N)
	T			0.555			0.469			0.403	0.440	0.27	0.356		
Nitrite (mg/L)	R										0.027	-	0.008	0.005 (mg/L)	1 (mg/L as N)
	T										0.007	-	-		
Nitrogen Total Kjeldahl (mg/L)	R										0.29	0.21	0.24	0.1 (mg/L)	0.15 (mg/L) *
	T										0.20	0.17	0.19		
pH	R	8.6	7.9	8.2	8.6	7.9	8.2	8.7	7.8	8.2	8.37	8.13	8.28		
	T	8.1	7.3	7.6	7.9	7.3	7.6	7.8	7.1	7.5	8.26	7.54	7.98		
Phosphorus Filtered Reactive (mg/L)	R										-	-	-	0.01 (mg/L)	
	T										-	-	-		

Note: All information obtained from DWSP.

GENERAL CHEMISTRY (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Phosphorus (Total) (mg/L)	R			0.013							-	-	-	0.01 (mg/L)	
	T										-	-	-		
Sodium (mg/L)	R			13.0			13.0	16.0	12.4	12.8	13.2	12.0	12.5	0.1 (mg/L)	
	T			13.0			13.0	14.0	12.6	12.7	13.4	12.0	12.6		
Total Solids (mg/L)	R										214	203	209.5	1 (mg/L)	
	T			208			204				217	207	213.5		
Turbidity -(2) (FTU)	R	40.0	0.3	1.2	40.0	0.40	1.3	65.0	0.20	1.3	22.0	0.35	1.12	0.01 (FTU)	1 (FTU)
	T	1.0	0.05	0.31	0.85	0.05	0.22	0.75	0.05	0.21	0.73	0.09	0.21		
METALS -(1)															
Aluminum (mg/L)	R	0.043	-	0.19	0.289	0.015	0.207	0.280	0.015	0.110	0.270	0.023	0.080	0.003 (mg/L)	0.1 (mg/L) G
	T	2.590	-	0.95	0.325	0.015	0.133	0.220	0.013	0.081	0.310	0.047	0.170		
Arsenic (mg/L)	R	-	-	-			-	-	-	-	0.002	-	-	0.001 (mg/L)	0.05 (mg/L)
	T	-	-	-			-	-	-	-	0.002	-	-		
Barium (mg/L)	R	0.028	0.010	0.018	0.024	0.020	0.022	0.020	0.019	0.019	0.022	0.017	0.021	0.001 (mg/L)	1 (mg/L)
	T	0.027	0.010	0.017	0.020	0.020	0.020	0.020	0.018	0.019	0.026	0.018	0.021		
Beryllium (mg/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	0.001 (mg/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Boron (mg/L)	R	0.052	-	0.027	0.024	0.019	0.021	0.022	0.019	0.021	0.040	0.030	0.031	0.02 (mg/L)	5 (mg/L)
	T	0.053	0.019	0.027	0.030	0.020	0.025	0.020	0.019	0.019	0.050	-	0.032		
Cadmium (mg/L)	R	-	-	-	0.001	0.001	0.001	-	-	-	-	-	-	0.0003 (mg/L)	0.005 (mg/L)
	T	-	-	-	0.001	0.001	0.001	-	-	-	-	-	-		

Note: All information obtained from DWSP.

METALS (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Chromium	R	-	-	-	0.003	0.002	0.002	-	-	-	0.002	-	-	0.001	0.05
(mg/L)	T	-	-	-	0.002	0.002	0.002	-	-	-	0.002	-	-	(mg/L)	(mg/L)
Cobalt	R				-	-	-	-	-	-	-	-	-	0.001	
(mg/L)	T				-	-	-	-	-	-	-	-	-	(mg/L)	
Copper	R	0.022	-	0.010	0.024	0.011	0.018	0.016	0.008	0.012	0.020	0.005	0.01	0.001	1
(mg/L)	T	0.003	-	-	0.017	-	0.009	0.008	0.005	0.006	0.009	-	0.004	(mg/L)	(mg/L)
Cyanide	R	-	-	-	-	-	-	-	-	-	-	-	-	0.001	0.2
(mg/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(mg/L)	(mg/L)
Iron	R	0.053	0.016	0.034	0.024	0.021	0.023	0.019	0.017	0.018	0.025	-	0.014	0.002	0.3
(mg/L)	T	0.033	0.005	0.017	0.006	0.003	0.005	0.045	0.002	0.024	0.073	-	0.018	(mg/L)	(mg/L) c
Lead	R	-	-	-	-	-	-	-	-	-	-	-	-	0.003	0.05
(mg/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(mg/L)	(mg/L)
Manganese	R				-	-	-	-	-	-	0.002	-	-	0.001	0.05
(mg/L)	T				-	-	-	0.002	-	-	0.003	-	-	(mg/L)	(mg/L)
Molybdenum	R				-	-	-	-	-	-	-	-	-	0.001	
(mg/L)	T				-	-	-	-	-	-	-	-	-	(mg/L)	
Mercury	R	-	-	-	-	-	0.13	0.09	-	0.05	-	-	-	0.01	1
(ug/L)	T	-	-	-	-	-	0.10	0.08	-	0.04	-	-	-	(ug/L)	(ug/L)
Nickel	R	0.003	-	-	0.006	-	0.004	0.006	-	0.003	-	-	-	0.002	
(mg/L)	T	0.004	-	-	-	-	-	0.006	-	0.003	-	-	-	(mg/L)	

Note: All information obtained from DWSP.

METALS (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Selenium	R	-	-	-			-	-	-	-	-	-	-	0.001	0.01
(mg/L)	T	-	-	-			-	-	-	-	-	-	-	(mg/L)	(mg/L)
Strontium	R				0.186	0.155	0.171	0.168	0.163	0.166	0.17	0.15	0.16	0.001	
(mg/L)	T				0.168	0.156	0.162	0.168	0.162	0.165	0.17	0.16	0.17	(mg/L)	
Tin	R														
(no units available)	T														
Uranium	R						-	-	-	-	.0004	.0003	.0003	0.002	0.02
(mg/L)	T						-	-	-	-	.0004	.0003	.0004	(mg/L)	(mg/L) t
Vanadium	R				0.003	0.003	0.003	0.005	-	0.003	-	-	-	0.001	
(mg/L)	T				0.002	0.002	0.002	0.003	-	0.002	-	-	-	(mg/L)	
Zinc	R			0.003			0.002			-	0.007	-	0.002	0.001	5
(mg/L)	T			0.003			0.002			-	0.005	-	0.002	(mg/L)	(mg/L) h
PURGEABLES -(1)															
Benzene -(3)	R	-	-	-	-	-	-	-	-	-	-	-	-	1	10
(ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L) h
Bromoform -(4)	R	-	-	-	-	-	-	-	-	-	-	-	-	1	350
(ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L) ++
Carbon Tetrachloride(5)	R			-	-	-	-	-	-	-	-	-	-	1	3
(ug/L)	T			-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L) h
Chlorobenzene -(6)	R			-	-	-	-	-	-	-	-	-	-	1	100-300
(ug/L)	T			-	-	-	-	-	-	-	-	-	-	(ug/L)	(ng/L) h*

Note: All information obtained from DWSP.

PURGEABLES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Chlorodibromomethane (ug/L) -(4)	R			-	-	-	-				12.0	-	2.0	1 (ug/L)	350 (ug/L) ++
	T			3.1	6.6	2.5	4.5				7.0	-	4.8		
Chloroform (ug/L) -(7)	R	-	-	-	-	-	-	1.6	-	0.6	8.0	-	1.3	1 (ug/L)	350 (ug/L) ++
	T	6.2	4.0	5.0	7.3	4.0	5.5	9.2	5.7	7.7	23.0	-	14.2		
1,2-Dichlorobenzene (ug/L) -(3)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	400 (ug/L) e
	T			-	-	-	-	-	-	-	-	-	-		
1,3-Dichlorobenzene (ug/L) -(3)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	400 (ug/L) e
	T			-	-	-	-	-	-	-	-	-	-		
1,4-Dichlorobenzene (ug/L) -(3)	R	-	-	-	0.2	-	-	-	-	-	-	-	-	1 (ug/L)	400 (ug/L) e
	T			-	0.4	-	-	-	-	-	-	-	-		
Dichlorobromomethane (ug/L) -(4)	R			-	1.6	-	-	1.5	-	0.63	7.0	-	1.2	1 (ug/L)	350 (ug/L) ++
	T			5.2	6.7	2.3	4.6	4.5	0.4	2.9	14.0	-	11.6		
1,1-Dichloroethane (ug/L) -(6)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	
	T			-	-	-	-	-	-	-	-	-	-		
1,2-Dichloroethane (ug/L) -(6)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	10 (ug/L) h
	T			-	-	-	-	-	-	-	-	-	-		
1,1-Dichloroethylene (ug/L) -(6)	R			-			-	-	-	-	-	-	-	1 (ug/L)	0.3 (ug/L) h
	T			-			-	-	-	-	-	-	-		
1,1,2-Dichloroethylene (ug/L) -(6)	R				-	-	-	-	-	-	-	-	-	1 (ug/L)	
	T				-	-	-	-	-	-	-	-	-		

Note: All information obtained from DWSP.

PURGEABLES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Dichloromethane (ug/L) -(4)	R			-	-	-	-							5 (ug/L)	40 (ug/L) c
	T			-	-	-	-								
1,2-Dichloropropane (ug/L) -(4)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	
	T			-	-	-	-	-	-	-	-	-	-		
Ethylbenzene (ug/L) -(3)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	1400 (ug/L) e
	T			-	-	-	-	-	-	-	-	-	-		
Ethylene Dibromide (ug/L) -(8)	R							-	-	-	-	-	-		
	T							-	-	-	-	-	-		
M-Xylene (ug/L) -(3)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	620 (ug/L) c
	T			-	-	-	-	-	-	-	-	-	-		
O-Xylene (ug/L) -(3)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	620 (ug/L) c
	T			-	-	-	-	-	-	-	-	-	-		
P-Xylene (ug/L) -(3)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	620 (ug/L) c
	T			-	-	-	-	-	-	-	-	-	-		
Toluene (ug/L) -(3)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	100 (ug/L) c
	T			-	-	-	-	-	-	-	-	-	-		
1,1,2,2-Tetrachloroethane (ug/L) -(6)	R			-	-	-	-	-	-	-	-	-	-	1 (ug/L)	1.7 (ug/L) e
	T			-	-	-	-	-	-	-	-	-	-		
Tetrachloroethene (ug/L)	R													1 (ug/L)	10 (ug/L) h
	T														

Note: All information obtained from DWSP.

PURGEABLES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]	
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG			
1,1,1-Trichloroethane	R			-	-	-	-	1.4	-	0.6	-	-	-	1	1000	
(ug/L) -(4)	T			-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L)	c
1,1,2-Trichloroethane	R			-			-	-	-	-	-	-	-	1	6	
(ug/L) -(4)	T			-			-	-	-	-	-	-	-	(ug/L)	(ug/L)	e
Trichloroethylene	R			-			-	-	-	-	-	-	-	1	30	
(ug/L) -(9)	T			-			-	-	-	-	-	-	-	(ug/L)	(ug/L)	h
Total Trihalomethanes	R										27	-	4.5	3	350	
(ug/L)	T										44	-	28.7	(ug/L)	(ug/L)	++
Trifluorochloro-	R										-	-	-	1		
toluene (ug/L)	T										-	-	-	(ug/L)		
ORGANOCHLORINES -(1)																
Aldrin	R	15	-	6	2	-	-	-	-	-	-	-	-	1	700	
(ng/L)	T	11	2	7	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)	**
Alpha BHC	R	23	-	8	2	-	-	-	-	-	-	-	-	1	700	
(ng/L)	T	15	-	5	2	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)	c
Alpha Chlordane	R	-	-	-	-	-	-	-	-	-	-	-	-	2	700	
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)	***
Beta BHC	R	2	-	-	2	-	-	-	-	-	-	-	-	1	300	
(ng/L)	T			-	-	-	4	-	-	-	-	-	-	(ng/L)	(ng/L)	c
Dieldrin	R	11	-	4	2	-	-	-	-	-	-	-	-	2	700	
(ng/L)	T	-	-	-	2	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)	**

Note: All information obtained from DWSP.

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Endrin	R			-	-	-	-	-	-	-	-	-	-	4	200
(ng/L) -(13)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)
Gamma Chlordane	R										-	-	-	2	700
(ng/L)	T										-	-	-	(ng/L)	(ng/L) ***
Heptachlor Epoxide	R	6	-	3	-	-	-	-	-	-	-	-	-	1	3000
(ng/L)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) +++
Heptachlor	R			-	2	-	-	-	-	-	-	-	-	1	3000
(ng/L)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) +++
Hexachlorobenzene	R										-	-	-	1	10
(ng/L)	T										-	-	-	(ng/L)	(ng/L) h
Hexachlorobutadiene	R			-	-	-	-	-	-	-	-	-	-		
(ug/L) -(10)	T			-	-	-	-	-	-	-	-	-	-		
Hexachloroethane	R			-	-	-	-	-	-	-	-	-	-	1	19000
(ng/L) -(11)	T			-	-	-	-	-	-	-	11.0	-	1.8	(ng/L)	(ng/L) e
Lindane	R	2	-	-	2	-	-	-	-	-	-	-	-	1	4000
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)
Methoxychlor	R			-	40	-	-	-	-	-	-	-	-	5	100000
(ng/L) -(12)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)
Mirex	R			-	-	-	-	-	-	-	-	-	-	5	
(ng/L)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	

I : All information obtained from DWSP.

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Octachlorostyrene (ng/L)	R										-	-	-	1 (ng/L)	
	T										-	-	-		
O,P-DDT (ng/L)	R										-	-	-	5 (ng/L)	30000 (ng/L) d
	T										-	-	-		
Oxychlordane (ng/L)	R										-	-	-	2 (ng/L)	
	T										-	-	-		
PCB Total (ng/L)	R										-	-	-	20 (ng/L)	3000 (ng/L) t
	T										-	-	-		
Pentachlorobenzene (ng/L)	R										-	-	-	1 (ng/L)	74000 (ng/L) e
	T										-	-	-		
P,P-DDD (ng/L) -(14)	R			-	-	-	-	-	-	-				5 (ng/L)	d
	T			-	-	-	-	-	-	-					
P,P-DDE (ng/L) -(15)	R			-	-	-	-	-	-	-	-	-	-	1 (ng/L)	d
	T			-	-	-	-	-	-	-	-	-	-		
P,P-DDT (ng/L) -(14)	R			-	-	-	-	-	-	-	-	-	-	5 (ng/L)	d
	T			-	-	-	-	-	-	-	-	-	-		
1,2,3,4-Tetra-chlorobenzene (ng/L)	R										-	-	-	1 (ng/L)	
	T										-	-	-		
1,2,3,5-Tetra-chlorobenzene (ng/L)	R										-	-	-	1 (ng/L)	
	T										-	-	-		

Note: All information obtained from DWSP.

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
1,2,4,5-Tetra-	R										-	-	-	1	38000
chlorobenzene (ng/L)	T										-	-	-	(ng/L)	(ng/L) e
Thiodan I	R										-	-	-	2	74000
(ng/L)	T										-	-	-	(ng/L)	(ng/L) ea
Thiodan II	R										-	-	-	4	74000
(ng/L)	T										-	-	-	(ng/L)	(ng/L) ea
Thiodan Sulphate	R										-	-	-	4	
(ng/L)	T										-	-	-	(ng/L)	
Toxaphene	R			-	-	-	-	-	-	-				0.02	
(no units available)	T			-	-	-	-	-	-	-				(ng/L)	
1,2,3-Trichlorobenzene	R										-	-	-	5	10000
(ng/L)	T										-	-	-	(ng/L)	(ng/L) y
1,2,4-Trichlorobenzene	R			-	-	-	-	-	-	-	-	-	-	5	15000
(ng/L) -(16)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) y
1,3,5-Trichlorobenzene	R										-	-	-	5	10000
(ng/L)	T										-	-	-	(ng/L)	(ng/L) y
2,3,6-Trichlorotoluene	R										-	-	-	5	
(ng/L)	T										-	-	-	(ng/L)	
2,4,5-Trichlorotoluene	R										-	-	-	5	10000
(ng/L)	T										-	-	-	(ng/L)	(ng/L) g

Note: All information obtained from DWSP.

TRIAZINES		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
TRIAZINES															
2,6,A-Trichlorotoluene	R										-	-	-	5	
(ng/L)	T										-	-	-	(ng/L)	
Alachlor	R							-	-	-	-	-	-	1	
(ng/L) -(17)	T							-	-	-	-	-	-		
Ametrine	R			-	-	-	-	-	-	-	-	-	-	50	
(ng/L) -(18)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	
Atratone	R										-	-	-		
(ng/L)	T										-	-	-		
Atrazine	R	52	-	-	109	50	55	-	-	-	-	-	-	50	46000
(ng/L) -(18)	T	-	-	-	101	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)
Bladex	R										-	-	-	100	10000
(ng/L)	T										-	-	-	(ng/L)	(ng/L)
Metolachlor	R										-	-	-		
(ng/L)	T										-	-	-		
Prometone	R										-	-	-	50	
(ng/L)	T										-	-	-	(ng/L)	
Prometryne	R										-	-	-	50	1000
(ng/L)	T										-	-	-	(ng/L)	(ng/L)
Propazine	R										-	-	-	50	
(ng/L)	T										-	-	-	(ng/L)	

Note: All information obtained from DWSP.

TRIAZINES (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Sencor	R										-	-	-	100	
(ng/L)	T										-	-	-	(ng/L)	
Simazine	R										-	-	-	50	10000
(ng/L)	T										-	-	-	(ng/L)	(ng/L)
SPECIAL PESTICIDES -(1)															
2,4-D	R			-	-	-	-	-	-	-	-	-	-	100 (6)	100000
(ng/L) -(19)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)
2,4-D Butyric Acid	R													200	18000
(ng/L)	T													(ng/L)	(ng/L)
Dicamba	R										-	-	-	100	87000
(ng/L)	T										-	-	-	(ng/L)	(ng/L)
Pentachlorophenol	R			-	-	-	-	-	-	-	-	-	-	50	10000
(ng/L) -(20)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) h
Picloram	R										-	-	-	100	
(ng/L)	T										-	-	-	(ng/L)	
2,4 D Propionic Acid	R										-	-	-	100	
(ng/L)	T										-	-	-	(ng/L)	
Silvex	R							-	-	-	-	-	-	50	10000
(ng/L) -(21)	T							-	-	-	-	-	-	(ng/L)	(ng/L)
2,4,5-T	R										-	-	-	50	
(ng/L)	T										-	-	-	(ng/L)	

Note: All information obtained from DWSP.

SPECIAL PESTICIDES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
2,3,4,5-Tetra-	R										-	-	-	50	
chlorophenol (ng/L)	T										-	-	-	(ng/L)	
2,3,5,6-Tetra-	R										-	-	-	50	
chlorophenol (ng/L)	T										-	-	-	(ng/L)	
2,3,4-Trichlorophenol	R										-	-	-	100	
(ng/L)	T										-	-	-	(ng/L)	
2,4,5-Trichlorophenol	R										-	-	-	50	
(ng/L)	T										-	-	-	(ng/L)	
2,4,6-Trichlorophenol	R			-	-	-	-	-	-	-	-	-	-	50	10000
(ng/L) -(22)	T			-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) h
ORGANOPHOSPHOROUS PEST'S.															
Diazinon	R				-	-	-	-	-	-				50	14000
(ng/L) -(23)	T				-	-	-	-	-	-				(ng/L)	(ng/L)
Dichlorovos	R														
(ng/L)	T														
Dursban	R														
(ng/L)	T														
Ethion	R				-	-	-	-	-	-					
(ng/L) -(24)	T				-	-	-	-	-	-					
Guthion	R														
(ng/L)	T														

Note: All information obtained from DWSP.

ORGANOPHOSPHOROUS PEST'S. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Malathion	R			-	-	-	-	-	-	-					
(ng/L) -(25)	T			-	-	-	-	-	-	-					
Methylparathion	R			-	-	-	-	-	-	-				50	7000
(ng/L) -(26)	T			-	-	-	-	-	-	-				(ng/L)	(ng/L)
Methyltrithion	R														
(ng/L)	T														
Mevinphos	R														
(ng/L)	T														
Parathion	R			-	-	-	-	-	-	-				50	35000
(ng/L) -(26)	T			-	-	-	-	-	-	-				(ng/L)	(ng/L)
Phorate	R														
(ng/L)	T														
Reldan	R														
(ng/L)	T														
Ronnel	R														
(ng/L)	T														
MASS SPEC.															
Di-n-Butyl Phthalate	R	6.9	-	3.1	11.8	0.15	4.1	-	-	-				0.1	34000
(ug/L) -(27)	T	7.5	-	4.7	23.2	0.15	7.9	-	-	-				(ug/L)	(ug/L) e

Note: All information obtained from OWSP.

MASS SPEC. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
N-Dichloromethylene-Pentachloroanaline (ug/L)	R													0.1 (ug/L)	
	T														
Diphenyl Ether (ug/L)	R													0.1 (ug/L)	
	T														
Fluoranthene (ug/L) -(28)	R			-	-	-	-	-	-	-				0.1 (ug/L)	
	T			-	-	-	-	-	-	-					
Hexachloropropene (ug/L)	R													0.1 (ug/L)	
	T														
Methyl Phenanthrene (ug/L)	R													0.1 (ug/L)	
	T														
Naphthalene (ug/L) -(6)	R	-	-	-	-	-	-	-	-	-				0.1 (ug/L)	
	T	-	-	-	-	-	-	-	-	-					
Pentachlorobutadiene (ug/L)	R													0.1 (ug/L)	
	T														
Pentachloropropane (ug/L)	R													0.1 (ug/L)	
	T														
Pentachloropropene (ug/L)	R													0.1 (ug/L)	
	T														
Pyrene (ug/L) -(28)	R			-	-	-	-	-	-	-				0.1 (ug/L)	
	T			-	-	-	-	-	-	-					

Note: All information obtained from DWSP.

MASS SPEC. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Tetrachlorobutane (ug/L)	R													0.1 (ug/L)	
	T														
Tetrachlorobiphenyl (ug/L)	R													0.1 (ug/L)	
	T														
BACTERIA -(1)															
Raw Water:															
Total Coliform MF	R	11000	0	240	3700	0	274	36000	0	198	164	2	64		
Total Coliform BKGD	R										580	26	265		
Fecal Coliform MF (count/100 mL)	R	1200	0	13	1200	0	36	4200	0	24	8000	0	1	0	0/0.1 (mL)
Standard Plate Count MF (count/mL)	R	3700	0	68	11000	0	71	1700	0	50	140	16	58	0	500
Treated Water:															
Present/Absent Test	T										0	0	0		
Total Coliform Background MF (count/100 mL)	T	10	0	0	5	0	0	6	0	0	0	0	0	0	OWDO Bacti
Fecal Coliform MF (count/100 mL)	T	1	0	0	0	0	0	1	0	0	0	0	0	0	OWDO Bacti

Note: All information obtained from DWSP.

BACTERIA (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Treated Water (cont'd.)															
Standard Plate Count MF (count/100 mL)	T	7	0	0	4	0	0	7	0	0	53	0	0		
If Present/Absent Test Positive:															
Coliform P/A	R														
	T														
Fecal Coliform P/A	R														
	T														
E. Coli P/A	R														
	T														
Aromonas P/A	R														
	T														
Staph. Aureus P/A	R														
	T														

Note: All information obtained from DWSP.

TABLE 5.0 - FOOTNOTES

1	= see individual footnotes for agency of guideline origin
c	= California State Department of Health action level
d	= OWDO for DDT (contains other isomers such as OPDDT and PPDDT)
e	= USEPA ambient guideline
ea	= United States Environmental Protection Agency (USEPA) ambient level for endosulfan (contains other isomers)
ep	= USEPA proposed maximum contaminant level for drinking water
g	= suggested Health and Welfare Canada/Ontario Ministry of the Environment guideline value
h	= World Health Organization (WHO) guideline
h*	= World Health Organization (WHO) odour threshold
mg/L	= milligrams per litre, parts per million (ppm)
ng/L	= nanograms per litre, parts per trillion (ppt)
Presence/Absence	= microbiological test to indicate presence or absence of coliform bacteria
R	= raw water
T	= treated drinking water
t	= ODWO interim maximum acceptable concentration (IMAC)
ug/L	= micrograms per litre, parts per billon (ppb)
y	= New York State (taste and odour) proposed drinking water guideline
++	= total trihalomethanes
+++	= combined total: heptachlor and heptachlor epoxide
*	= if other than DWSP detection limit
**	= total of aldrin and dieldrin
***	= chlordane is a mixture of alpha and gamma isomers
!	= Ministry of the Environment and Health and Welfare Canada (IMAC)
-	= no quantifiable result
G	= ODWO suggested guideline

TABLE 5.0 - FOOTNOTES (cont'd)

(1) = Testing for all parameters in this section was carried out under a Metro Toronto sampling program for the period 1983 - 85; and under DWSP for 1986

(2) = Turbidity data is taken from plant records. No DWSP turbidity data is recorded in Table 5.0.

(3) = Detection limit of 0.1 µg/L used for 1983 - 85 testing

(4) = Detection limit of 0.4 µg/L used for 1983 - 85 testing

(5) = Detection limit of 0.2 µg/L used for 1983 - 84 testing; detection limit of 0.3 µg/L used for 1985 testing

(6) = Detection limit of 0.2 µg/L used for 1983 - 85 testing

(7) = Detection limit of 0.2 µg/L used for 1983 - 85 testing

(8) = Detection limit of 0.2 µg/L used for 1985 testing

(9) = Detection limit of 0.2 µg/L used for 1983, 85 testing; detection limit of 0.4 µg/L used in 1984

(10) = Detection limit of 0.3 µg/L used 1983 - 85 testing

(11) = Detection limit of 0.15 µg/L used for 1983 - 85 testing

(12) = Detection limit of 0.03 µg/L used for 1983 - 85 testing

(13) = Detection limit of 2 ng/L used for 1983 - 85 testing

(14) = Detection limit of 0.01 µg/L used for 1983 - 85 testing

(15) = Detection limit of 2 ng/L for 1983 - 85 testing

(16) = Detection limit of 0.08 µg/L used for 1983 - 85 testing

(17) = Detection limit of 1 µg/L used for 1985 testing

(18) = Detection limit of 0.03 µg/L used for 1983 testing; limit of 0.1 µg/L

(19) = Detection limit of 0.05 µg/L used in 1983 - 85; limit of 0.5 µg/L used in 1984

TABLE 5.0 - FOOTNOTES (cont'd)

(20) = Detection limit of 1 µg/L used in 1983 - 85 testing

(21) = Detection limit of 0.5 µg/L used in 1985 testing

(22) = Detection limit of 0.5 µg/L used for 1983 - 85 testing

(23) = Detection limit of 0.05 µg/L for 1984 - 85 testing

(24) = Detection limit of 1 µg/L used for 1984 - 85 testing

(25) = Detection limit of 0.05 µg/L used for 1983 testing; limit of 0.01 µg/L used for 1984 testing; limit of 0.1 µg/L used for 1985 testing

(26) = Detection limit of 0.025 µg/L used in 1983 testing; detection limit of 0.1 µg/L used in 1984 - 85 testing

(27) = Detection limit of 0.3 µg/L used in 1983 - 85 testing

(28) = Detection limit of 0.25 µg/L used in 1983 testing; limit of 0.3 µg/L used in 1984 - 85 testing.

WPOS - R.C. HARRIS WTP

GENERAL CHEMISTRY		1986 *												DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
GENERAL CHEMISTRY															
Alkalinity (mg/L)	R	96.0					98.0	98.1	96.6	99.8	97.9	99.4	99.4	0.2 (mg/L)	
	T	90.8					88.2	88.9	88.0	90.7	87.7	89.8	92.6		
Ammonium (Total) (mg/L)	R	0.102					0.038	0.040	0.016	0.010	0.040	-	-	0.05 (mg/L)	
	T	0.012					0.010	0.030	0.014	0.018	0.062	0.146	0.126		
Calcium (mg/L)	R	39.5					41.9	39.5	38.8	40.7	37.9	39.2	40.0	0.1 (mg/L)	
	T	39.5					41.4	39.8	39.2	41.0	38.4	40.4	39.9		
Chloride (mg/L)	R	25.8					24.0	25.0	23.0	23.5	23.5	24.5	24.5	0.2 (mg/L)	250 (mg/L)
	T	27.6					28.0	27.5	26.0	26.5	27.5	27.5	26.5		
Colour (HCU)	R	2.5					2.5	3.0	2.0	-	-	-	-	0.5 (TCU)	5 (TCU)
	T	-					-	-	-	-	-	-	-		
Conductivity (umho/cm)	R	329					322	325	313	317	318	320	331	0.01 (umho/cm)	
	T	334					328	334	318	322	325	327	333		
Field Chlorine (Combined)	R													0.1 (mg/L)	
	T	0.68					0.17	0.19	0.20	0.15	0.55	0.70	0.75		
Field Chlorine (Free)	R													0.1 (mg/L)	
	T	0.07					0.55	0.45	0.50	0.50	0.10				
Field Chlorine (Total)	R													0.1 (mg/L)	
	T	0.75					0.72	0.64	0.70	0.65	0.65	0.75	0.85		
Field pH	R	8.0					8.5	8.5	8.1	7.8	8.4	7.9	8.1	0.2	
	T	7.5					7.4	7.5	7.4	7.3	7.5	7.2	7.4		

* All data in Table 5.1 was obtained from the DWSP.

GENERAL CHEMISTRY (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Field Temperature (^{o}C)	R	2.5					10.0	17.0	12.0	6.0	13.0	11.0	5.5		
	T	3.0					10.5	16.5	13.0	6.0	10.0	5.0	4.5		
Field Turbidity (FTU)	R	0.80					0.65	0.20	1.00	1.00	0.95	7.50	1.20		1 (FTU)
	T	0.15					0.36	0.54	0.10	0.15	0.20	0.33	0.19		
Fluoride (mg/L)	R	0.14					0.16	0.16	0.15	0.12	0.14	0.15	0.16	0.01 (mg/L)	2.4 (mg/L)
	T	1.17					1.20	1.36	1.23	1.19	1.07	1.13	1.31		
Hardness (mg/L)	R	133.2					140.0	133.0	130.0	135.5	127.5	132.5	133.0	0.5 (mg/L)	
	T	133.2					138.5	134.0	131.5	136.5	129.0	136.0	133.5		
Magnesium (mg/L)	R	8.40					8.60	8.30	8.05	8.25	8.05	8.50	8.00	0.05 (mg/L)	c
	T	8.40					8.50	8.45	8.20	8.35	8.00	8.55	8.20		
Nitrate (mg/L)	R	0.385					0.285	0.285	0.385	0.440	0.335			0.05 (mg/L)	10 (mg/L as N)
	T	0.395					0.295	0.270	0.340	0.440	0.335				
Nitrite (mg/L)	R	-					-	0.013	0.027	-	-	0.008	-	0.005 (mg/L)	1 (mg/L as N)
	T	-					-	-	-	0.007	-	0.007	-		
Nitrogen Total Kjeldahl (mg/L)	R	0.23					0.29	0.26	0.22	0.23	0.21	0.27	0.10	0.1 (mg/L)	
	T	0.17					0.20	0.20	0.18	0.19	0.20	0.29	0.27		
pH	R	8.13					8.37	8.29	8.31	8.25	8.31	8.29	8.30		
	T	7.54					8.05	7.86	8.26	8.17	7.99	7.98	8.26		
Phosphorus Filtered Reactive (mg/L)	R	-					-	-	-	-	-	-	-	0.01 (mg/L)	
	T	-					-	-	-	-	-	-	-		

GENERAL CHEMISTRY (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Phosphorus (Total) (mg/L)	R	-					0.013	-	-	-	-	0.033	0.019	0.01 (mg/L)	
	T	-					-	0.017	-	-	-		0.018		
Sodium (mg/L)	R	12.0					13.2	13.2	12.4	12.4	12.1	12.1	12.2	0.1 (mg/L)	
	T	12.5					12.7	13.4	12.2	12.7	12.0	12.5	12.4		
Total Solids (mg/L)	R	214.0					209.0	211.0	203.0	213.0	207.0	214.0	215.0	1 (mg/L)	
	T	217.0					213.0	217.0	207.0	216.0	211.0	213.0	216.0		
Turbidity (FTU)	R	1.05					0.77	1.62	0.89	1.43	1.15	13.00	2.70	0.01 (FTU)	1 (FTU)
	T	0.10					0.32	0.69	0.24	0.32	0.30	0.10	0.22		
METALS															
Aluminum (mg/L)	R	0.097					0.025	0.048	0.031	0.270	0.023	0.043	0.034	0.003 (mg/L)	0.1 (mg/L) G
	T	0.047					0.220	0.310	0.160	0.075	0.200	0.069	0.097		
Arsenic (mg/L)	R	-					-	0.002	-	-	-	-	-	0.001 (mg/L)	0.05 (mg/L)
	T	-					-	-	-	-	0.002	-	-		
Barium (mg/L)	R	0.017					0.021	0.020	0.021	0.022	0.022	0.023	0.019	0.001 (mg/L)	1 (mg/L)
	T	0.018					0.021	0.021	0.021	0.021	0.026	0.021	0.021		
Beryllium (mg/L)	R	-					-	-	-	-	-	-	-	0.001 (mg/L)	
	T	-					-	-	-	-	-	-	-		
Boron (mg/L)	R	0.04					0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02 (mg/L)	5 (mg/L)
	T	0.05					0.03	0.04	-	0.03	0.03	0.04	0.03		
Cadmium (mg/L)	R	-					-	-	-	-	-	-	-	0.0003 (mg/L)	0.005 (mg/L)
	T	-					-	-	-	-	-	-	-		

METALS (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT*	DRINKING WATER OBJ. GUIDELINE[1]
Chromium (mg/L)	R	0.002					-	-	-	-	-	-	-	0.001 (mg/L)	0.05 (mg/L) 50 (mg/L)
	T	0.002					-	-	-	-	-	-	-		
Cobalt (mg/L)	R	-					-	-	-	-	-	-	-	0.001 (mg/L)	
	T	-					-	-	-	-	-	-	-		
Copper (mg/L)	R	0.005					0.006	0.010	0.010	0.011	0.020	0.033	0.016	0.001 (mg/L)	1 (mg/L)
	T	0.009					0.005	0.003	-	0.002	0.003	0.002	0.002		
Cyanide (mg/L)	R	-					-	-	-	-	-	-	-	0.001 (mg/L)	0.2 (mg/L)
	T	-					-	-	-	-	-	-	-		
Iron (mg/L)	R	-					0.016	0.021	0.010	0.025	0.011	0.069	0.039	0.002 (mg/L)	0.03 (mg/L) c
	T	0.025					0.003	0.007	-	-	0.073	-	-		
Lead (mg/L)	R	-					-	-	-	-	0.011	-	-	0.003 (mg/L)	0.05 (mg/L)
	T	-					-	-	-	-	-	-	-		
Manganese (mg/L)	R	-					-	0.002	-	0.002	-	0.004	0.002	0.001 (mg/L)	0.05 (mg/L)
	T	0.003					-	-	-	-	-	-	-		
Molybdenum (mg/L)	R	-					-	-	-	-	-	-	-	0.001 (mg/L)	
	T	-					-	-	-	-	-	-	-		
Mercury (ug/L)	R	-					-	-	-	-	-	0.02	0.02	0.01 (ug/L)	1 (ug/L)
	T	-					-	-	-	-	-	0.03	0.02		
Nickel (mg/L)	R	-					-	-	-	-	-	-	-	0.002 (mg/L)	
	T	-					-	-	-	-	-	-	-		

METALS (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Selenium (mg/L)	R	-					-	-	-	-	-	-	-	0.001 (mg/L)	0.01 (mg/L)
	T	-					-	-	-	-	-	-	-		
Strontium (mg/L)	R	0.15					0.16	0.17	0.17	0.17	0.17	0.18	0.15	0.001 (mg/L)	
	T	0.16					0.17	0.17	0.17	0.16	0.17	0.17	0.170		
Tin (mg/L) (no units available)	R														
	T														
Uranium (ug/L)	R	-					-	0.361	0.330	0.370	0.300	0.370	0.340	0.002 (ug/L)	0.02 (ug/L) t
	T	-					-	0.413	0.300	0.370	0.320	0.370	0.380		
Vanadium (mg/L)	R	-					-	-	-	-	-	-	-	0.001 (mg/L)	
	T	-					-	-	-	-	-	-	-		
Zinc (mg/L)	R	0.005					-	-	-	0.007	-	0.002	-	0.001 (mg/L)	5 (mg/L) h
	T	0.003					-	-	-	0.005	-	-	-		
PURGEABLES															
Benzene (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	10 (ug/L) h
	T	-					-	-	-	-	-	-	-		
Bromoform (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	350 (ug/L) ++
	T	-					-	-	-	-	-	-	-		
Carbon Tetrachloride (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	3 (ug/L) h
	T	-					-	-	-	-	-	-	-		
Chlorobenzene (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	100-300 (ng/L) h* 100 (mg/L)
	T	-					-	-	-	-	-	-	-		

PURGEABLES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Chlorodibromomethane (ug/L)	R	12.0(1)					-	-	-	-	-	-	-	1 (ug/L)	350 (ug/L) ++
	T	- (1)					7.0	7.0	6.0	6.0	3.0	-	4.0		
Chloroform (ug/L)	R	8.0(1)					-	-	-	-	-	-	-	1 (ug/L)	350 (ug/L) ++
	T	- (1)					23.0	20.0	16.0	17.0	9.0	5.0	6.0		
1,2-Dichlorobenzene (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	400 (ug/L) e
	T	-					-	-	-	-	-	-	-		
1,3-Dichlorobenzene (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	400 (ug/L) e
	T	-					-	-	-	-	-	-	-		
1,4-Dichlorobenzene (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	400 (ug/L) e
	T	-					-	-	-	-	-	-	-		
Dichlorobromomethane (ug/L)	R	7.0(1)					-	-	-	-	-	-	-	- (ug/L)	350 (ug/L) ++
	T	- (1)					14.0	13.0	11.0	12.0	8.0	5	6		
1,1-Dichloroethane (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	10 (ug/L)
	T	-					-	-	-	-	-	-	-		
1,2-Dichloroethane (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	10 (ug/L) h
	T	-					-	-	-	-	-	-	-		
1,1-Dichloroethylene (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	0.3 (ug/L) h
	T	-					-	-	-	-	-	-	-		
1,1,2-Dichloroethylene (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	
	T	-					-	-	-	-	-	-	-		

PURGEABLES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Dichloromethane (ug/L)	R T													5 (ug/L)	40 (ug/L) c
1,2-Dichloropropane (ug/L)	R T	-					-	-	-	-	-	-	-	1 (ug/L)	
		-					-	-	-	-	-	-	-		
Ethylbenzene (ug/L)	R T	-					-	-	-	-	-	-	-	1 (ug/L)	1400 (ug/L) e
		-					-	-	-	-	-	-	-		
Ethylene Dibromide (ug/L)	R T						-	-	-	-	-	-	-		
							-	-	-	-	-	-	-		
M-Xylene (ug/L)	R T	-					-	-	-	-	-	-	-	1 (ug/L)	620 (ug/L) c
		-					-	-	-	-	-	-	-		
O-Xylene (ug/L)	R T	-					-	-	-	-	-	-	-	1 (ug/L)	620 (ug/L) c
		-					-	-	-	-	-	-	-		
P-Xylene (ug/L)	R T	-					-	-	-	-	-	-	-	1 (ug/L)	620 (ug/L) c
		-					-	-	-	-	-	-	-		
Toluene (ug/L)	R T	-					-	-	-	-	-	-	-	1 (ug/L)	100 (ug/L) c
		-					-	-	-	-	-	-	-		
1,1,2,2-Tetra-chloroethane (ug/L)	R T	-					-	-	-	-	-	-	-	1 (ug/L)	1.7 (ug/L) e
		-					-	-	-	-	-	-	-		
Tetrachloroethane (ug/L)	R T													1 (ug/L)	10 (ug/L) h

PURGEABLES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
1,1,1-Trichloroethane (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	1000 (ug/L) c
	T	-					-	-	-	-	-	-	-		
1,1,2-Trichloroethane (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	6 (ug/L) e
	T	-					-	-	-	-	-	-	-		
Trichloroethylene (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	30 (ug/L) h
	T	-					-	-	-	-	-	-	-		
Total Trihalomethanes (ug/L)	R	27.0(1)					-	-	-	-	-	-	-	3 (ug/L)	350 (ug/L) ++
	T	- (1)					44.0	40.0	33.0	35.0	20.0	10.0	16.0		
Trifluorochloro-toluene (ug/L)	R	-					-	-	-	-	-	-	-	1 (ug/L)	
	T	-					-	-	-	-	-	-	-		
ORGANOCHLORINES															
Aldrin (ng/L)	R	-					-	-	-	-	-	-	-	1 (ng/L)	700 (ng/L) **
	T	-					-	-	-	-	-	-	-		
Alpha BHC (ng/L)	R	-					-	-	-	-	-	-	-	1 (ng/L)	700 (ng/L) c
	T	-					-	-	-	-	-	-	-		
Alpha Chlordane (ng/L)	R	-					-	-	-	-	-	-	-	2 (ng/L)	700 (ng/L) ***
	T	-					-	-	-	-	-	-	-		
Beta BHC (ng/L)	R	-					-	-	-	-	-	-	-	1 (ng/L)	300 (ng/L) c
	T	-					-	-	-	-	-	-	-		
Dieldrin (ng/L)	R	-					-	-	-	-	-	-	-	2 (ng/L)	700 (ng/L) **
	T	-					-	-	-	-		-	-		

ORGANOCHLORINES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ[1] GUIDELINE
Endrin		-					-	-	-	-	-	-	-	4	200
(ng/L)	T	-					-	-	-	-	-	-	-	(ng/L)	(ng/L)
Gamma Chlordane	R	-					-	-	-	-	-	-	-	2	700
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) ***
Heptachlor Epoxide	R	-					-	-	-	-	-	-	-	1	3000
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) +++
Heptachlor	R	-					-	-	-	-	-	-	-	1	3000
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) +++
Hexachlorobenzene	R	-					-	-	-	-	-	-	-	1	10
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) h
Hexachlorobutadiene	R	-					-	-	-	-	-				
(ug/L)	T	-					-	-	-	-					
Hexachloroethane	R	-					-	-	-	-	-	-	-	1	19000
(ng/L)	T	-					11.0	-	-	-		-	-	(ng/L)	(ng/L) e
Lindane	R	-					-	-	-	-	-	-	-	1	4000
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L)
Methoxychlor	R	-					-	-	-	-	-	-	-	5	100000
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L)
Mirex	R	-					-	-	-	-	-	-	-	5	
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	

ORGANOCHLORINES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Octachlorostyrene (ng/L)	R	-					-	-	-	-	-	-	-	1 (ng/L)	
	T	-					-	-	-	-		-	-		
O,P-DDT (ng/L)	R	-					-	-	-	-	-	-	-	5 (ng/L)	30000 (ng/L) d
	T	-					-	-	-	-		-	-		
Oxychlordane (ng/L)	R	-					-	-	-	-	-	-	-	2 (ng/L)	
	T	-					-	-	-	-		-	-		
PCB Total (ng/L)	R	-					-	-	-	-	-	-	-	20 (ng/L)	3000 (ng/L) t
	T	-					-	-	-	-		-	-		
Pentachlorobenzene (ng/L)	R	-					-	-	-	-	-	-	-	1 (ng/L)	74000 (ng/L) e
	T	-					-	-	-	-		-	-		
P,P-DDD (ng/L)	R													5 (ng/L)	d
	T														
P,P-DDE (ng/L)	R	-					-	-	-	-	-	-	-	1 (ng/L)	d
	T	-					-	-	-	-		-	-		
P,P-DDT (ng/L)	R	-					-	-	-	-	-	-	-	5 (ng/L)	d
	T	-					-	-	-	-		-	-		
1,2,3,4-Tetra-chlorobenzene (ng/L)	R	-					-	-	-	-	-	-	-	1 (ng/L)	38000 (ng/L) e
	T	-					-	-	-	-		-	-		
1,2,3,5-Tetra-chlorobenzene (ng/L)	R	-					-	-	-	-	-	-	-	1 (ng/L)	15000 (ng/L) e
	T	-					-	-	-	-		-	-		

ORGANOCHLORINES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
1,2,4,5-Tetra-	R	-					-	-	-	-	-	-	-	1	38000
chlorobenzene (ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) e
Thiodan I	R	-					-	-	-	-	-	-	-	2	74000
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) ea
Thiodan II	R	-					-	-	-	-	-	-	-	4	74000
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) ea
Thiodan Sulphate	R	-					-	-	-	-	-	-	-	4	
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	
Toxaphene	R														
(no units available)	T														
1,2,3-Trichlorobenzene	R	-					-	-	-	-	-	-	-	5	10000
(ng/L)	T	-					-	-	-	-	-	-	-	(ng/L)	(ng/L) y
1,2,4-Trichlorobenzene	R	-					-	-	-	-	-	-	-	5	15000
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) y
1,3,5-Trichlorobenzene	R	-					-	-	-	-	-	-	-	5	10000
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) y
2,3,6-Trichlorotoluene	R	-					-	-	-	-	-	-	-	5	
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	
2,4,5-Trichlorotoluene	R	-					-	-	-	-	-	-	-	5	10000
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	(ng/L) g

TRIAZINES		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
TRIAZINES															
2,6,A-Trichlorotoluene	R	-					-	-	-	-	-	-	-	5	
(ng/L)	T	-					-	-	-	-		-	-	(ng/L)	
Alachlor	R							-	-	-	-	-	-	500	5
(ng/L)	T							-	-	-	-	-	-	(ng/L)	(mg/L) t
Ametrine	R						-	-	-	-	-	-	-	50	
(ng/L)	T						-	-	-	-	-	-	-	(ng/L)	
Atratone	R						-	-	-	-	-	-	-	50	
(ng/L)	T						-	-	-	-	-	-	-	(ng/L)	
Atrazine	R						-	-	-	-	-	-	-	50	46000
(ng/L)	T						-	-	-	-	-	-	-	(ng/L)	(ng/L) !
Bladex	R						-	-	-	-	-	-	-	100	10000
(ng/L)	T						-	-	-	-	-	-	-	(ng/L)	(ng/L) !
Metolachlor	R							-	-	-	-	-	-	500	
(ng/L)	T							-	-	-	-	-	-	(ng/L)	
Prometone	R						-	-	-	-	-	-	-	50	
(ng/L)	T						-	-	-	-	-	-	-	(ng/L)	
Prometryne	R						-	-	-	-	-	-	-	50	1000
(ng/L)	T						-	-	-	-	-	-	-	(ng/L)	(ng/L) !
Propazine	R						-	-	-	-	-	-	-	50	
(ng/L)	T						-	-	-	-	-	-	-	(ng/L)	

TRIAZINES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Sencor	R	-					-	-	-	-	-	-	-	100	
(ng/L)	T	-					-	-	-	-	-	-	-	(ng/L)	
Simazine	R						-	-	-	-	-	-	-	50	10000
(ng/L)	T						-	-	-	-	-	-	-	(ng/L)	(ng/L) !
SPECIAL PESTICIDES															
2,4-D	R								-		-			100	10000
(ng/L)	T								-		-			(ng/L)	(ng/L)
2,4-D Butyric Acid	R								-		-			200	18000
(ng/L)	T								-		-			(ng/L)	(ng/L) !
Dicamba	R								-		-			100	87000
(ng/L)	T								-		-			(ng/L)	(ng/L) !
Pentachlorophenol	R								-		-			50	10000
(ng/L)	T								-		-			(ng/L)	(ng/L) h
Picloram	R													100	
(ng/L)	T													(ng/L)	
2,4-D Propionic Acid	R								-		-			100	
(ng/L)	T								-		-			(ng/L)	
Silvex	R								-		-			50	10000
(ng/L)	T								-		-			(ng/L)	(ng/L)
2,4,5-T	R								-		-			50	
(ng/L)	T								-		-			(ng/L)	

SPECIAL PESTICIDES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE [1]
2,3,4,5-Tetra chlorophenol (ng/L)	R T								- -					50 (ng/L)	
2,3,5,6 Tetra chlorophenol (ng/L)	R T								- -					50 (ng/L)	
2,3,4-Trichlorophenol (ng/L)	R T								- -		- -			100 (ng/L)	
2,4,5-Trichlorophenol (ng/L)	R T								- -		- -			50 (ng/L)	
2,4,6 Trichlorophenol (ng/L)	R T								- -		- -			50 (ng/L)	10000 (ng/L) h
ORGANOPHOSPHOROUS PEST'S.															
Diazinon (ng/L)	R T													50 (ng/L)	14000 (ng/L)
Dichlorovos (ng/L)	R T														
Dursban (ng/L)	R T														
Ethion (ng/L)	R T														
Guthion (ng/L)	R T														

ORGANOPHOSPHOROUS PEST'S. (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Malathion (ng/l)	P T														
Methylparathion (ng/l)	P T													50 (ng/L)	7000 (ng/L)
Methyltrithion (ng/L)	P T														
Mevinphos (ng/L)	P T														
Parathion (ng/L)	P T													50 (ng/L)	35000 (ng/L)
Phorbate (ng/L)	P T														
Reldan (ng/L)	P T														
Ronnel (ng/L)	P T														
MASS SPEC.															
Di-N-Butyl Phthalate (ug/L)	P T													0.1 (ug/L)	34000 (ug/L) e

MASS SPEC. (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
N Dichloromethylene Pentachloroanaline (ug/L)	R													0.1 (ug/L)	
	I														
Diphenyl Ether (ug/L)	R													0.1 (ug/L)	
	I														
Fluoranthene (ug/L)	R													0.1 (ug/L)	
	I														
Hexachloropropene (ug/L)	R													0.1 (ug/L)	
	I														
Methyl Phenanthrene (ug/L)	R													0.1 (ug/L)	
	I														
Naphthalene (ug/L)	R													0.1 (ug/L)	
	I														
Pentachlorobutadiene (ug/L)	R													0.1 (ug/L)	
	I														
Pentachloropropane (ug/L)	R													0.1 (ug/L)	
	I														
Pentachloropropene (ug/L)	R													0.1 (ug/L)	
	I														
Pyrene (ug/L)	R													0.1 (ug/L)	
	I														

MASS SPEC. (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Tetrachlorbutane (ug/L)	R T													0.1 (ug/L)	
Tetrachlorobiphenyl (ug/L)	R T													0.1 (ug/L)	
BACTERIA															
Raw Water:															
Total Coliform MF	R	39					2	19	164	94	66	6	57		
Total Coliform BKGD	R	187					126	26	580	500	170	19	300		
Fecal Coliform MF (count/100 mL)	R	4					0	I	38	8	5	2	1	0	0/0.1 (mL)
Standard Plate Count MF (count/mL)	R	35					16	33	95	140	27	460	56	0	500
Treated Water:															
Present/Absent Test	T	A					A	A	A	A	A	A	A		
Total Coliform Background MF (count/100 mL)	T	0					0	0	1	0	0	0	0	0	OWDO Bacti
Fecal Coliform MF (count/100 mL)	T													0	OWDO Bacti

BACTERIA (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Treated Water (cont'd.)															
Standard Plate Count MF (count/100 mL)	T	0					0	3	4	0	0	4	3		
If Present/Absent Test Positive:															
Coliform P/A	R														
	T														
Fecal Coliform P/A	R														
	T														
E. Coli P/A	R														
	T														
Aromonas P/A	R														
	T														
Staph. Aureus P/A	R														
	T														

TABLE 5.1 - FOOTNOTES

l	= see individual footnotes for agency of guideline origin
c	= California State Department of Health action level
d	= OWDO for DDT (contains other isomers such as OPDDT and PPDDT)
e	= USEPA ambient guideline
ea	= United States Environmental Protection Agency (USEPA) ambient level for endosulfan (contains other isomers)
ep	= USEPA proposed maximum contaminant level for drinking water
g	= suggested Health and Welfare Canada/Ontario Ministry of the Environment guideline value
h	= World Health Organization (WHO) guideline
h*	= World Health Organization (WHO) odour threshold
mg/L	= milligrams per litre, parts per million (ppm)
ng/L	= nanograms per litre, parts per trillion (ppt)
Presence/Absence	= microbiological test to indicate presence or absence of coliform bacteria
R	= raw water
T	= treated drinking water
t	= ODWO interim maximum acceptable concentration (IMAC)
ug/L	= micrograms per litre, parts per billon (ppb)
y	= New York State (taste and odour) proposed drinking water guideline
++	= total trihalomethanes
+++	= combined total: heptachlor and heptachlor epoxide
*	= if other than DWSP detection limit
**	= total of aldrin and dieldrin
***	= chlordane is a mixture of alpha and gamma isomers
!	= Ministry of the Environment and Health and Welfare Canada (IMAC)
-	= no quantifiable result
G	= ODWO suggested guideline
(l)	= Data point suspect.

TABLE 6.0: PLANKTON ORGANISMS -(1)
(TREATED WATER)

WPOS - R. C. HARRIS WTP

		1986	1985	1984	1983
JAN	Max.	2.7	16	4.6	12
	Min.	NIL	NIL	0.85	2.1
	Avg.	1.1	7.4	2.8	6.4
	No. Tests	-(2)			
FEB	Max.	2.2	14	5.3	15
	Min.	NIL	0	0.92	4.5
	Avg.	0.77	5.2	2.4	8.3
	No. Tests				
MAR	Max.	1.8	7.5	3.8	6.2
	Min.	0	2.3	NIL	3.7
	Avg.	0.52	3.9	1.6	5.1
	No. Tests				
APR	Max.	3.6	4.6	4.0	12
	Min.	NIL	1.7	2.4	3.8
	Avg.	0.57	3.6	3.2	7.6
	No. Tests				
MAY	Max.	6.8	2.6	27	8.6
	Min.	3.3	NIL	2.8	5.3
	Avg.	5.0	1.4	11	6.5
	No. Tests				
JUN	Max.	4.1	2.2	32	8.8
	Min.	NIL	NIL	1.5	3.3
	Avg.	1.8	1.4	11	5.5
	No. Tests				

		1986	1985	1984	1983
JUL	Max.	2.5	9.7	18	12
	Min.	NIL	3.0	0	4.0
	Avg.	0.59	8.1	5.3	6.4
	No. Tests				
AUG	Max.	3.1	2.2	5.1	9.8
	Min.	NIL	0	0.99	1.1
	Avg.	0.42	1.1	3.0	7.1
	No. Tests				
SEP	Max.	2.8	6.7	14	4.7
	Min.	1.3	0	0	1.7
	Avg.	2.0	3.1	4.8	3.5
	No. Tests				
OCT	Max.	6.7	2.9	6.2	6.2
	Min.	NIL	0	0	1.7
	Avg.	0.97	1.0	4.0	4.8
	No. Tests				
NOV	Max.	5.1	4.2	2.7	5.1
	Min.	1.6	0	NIL	3.0
	Avg.	3.2	1.5	1.1	3.9
	No. Tests				
DEC	Max.		0	3.6	6.5
	Min.		0	NIL	0
	Avg.		0	1.6	2.9
	No. Tests				

Notes:

(1) Data referred to as "Plankton Organisms (A.S.U. per 1 mL)" in R. C. Harris records. Includes zoo plankton and algae.

(2) Max., Min., Avg. data only available. Plant lab staff indicate that tests are usually done each week and when number of backwashes per day >40. Data obtained from monthly summary sheets.

WPOS - R. C. HARRIS WTP

	TOTAL COLIFORM (1)			FECAL COLIFORM (1)			STD. PLATE COUNT (2)			FECAL STREPTOCOCCUS (2)		
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN R	2100	0	33	450	0	1	340	0	11	0	0	0
T	0	0	0	0	0	0	2	0	0	0	0	0
FEB R	8300	0	29	380	0	1	770	0	9	0	0	0
T	0	0	0	0	0	0	1	0	0	0	0	0
MAR R	16000	0	59	8000	0	5	870	0	30	0	0	0
T	3	0	0	0	0	0	9	0	0	0	0	0
APR R	330	0	3	18	0	0	58	0	3	0	0	0
T	0	0	0	0	0	0	1	0	0	0	0	0
MAY R	84	0	4	1	0	0	85	0	17	0	0	0
T	0	0	0	0	0	0	1	0	0	0	0	0
JUN R	450	0	12	4	0	0	530	1	14	0	0	0
T	3	0	0	0	0	0	530	0	0	0	0	0
JUL R	390	0	13	18	0	1	1200	0	12	0	0	0
T	1	0	0	0	0	0	1	0	0	0	0	0
AUG R	860	2	55	98	0	2	290	1	35	0	0	0
T	0		0	0	0	0	1	0	0	0	0	0
SEP R	710	0	49	250	0	2	480	1	46	0	0	0
T	2	0	0	0	0	0	1	0	0	0	0	0
OCT R	2600	0	41	270	0	2	5400	1	44			
T	0	0	0	0	0	0	1	0	0			
NOV R	3100	1	40	160	0	4	2000	1	46			
T	1	0	0	0	0	0	3	0	0			
DEC R	6300	18	239	2100	2	19	1300	5	68			
T	1	0	0.033	0	0	0	1	0	0.026			

Note: (1) Sample Size = 100 ml (2) Sample Size = 1 ml

- Averages are rounded to the nearest whole number
- Blanks indicate no testing carried out.

WPOS - R. C. HARRIS WTP

	TOTAL COLIFORM (1)			FECAL COLIFORM (1)			STD. PLATE COUNT (2)			FECAL STREPTOCOCCUS (2)		
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN R	13000	0	232	930	0	18	1600	0	45	0	0	0
T	1	0	0	0	0	0	2	0	0	0	0	0
FEB R	890	0	129	170	0	12	290	0	28	1	0	0
T	2	0	0	0	0	0	1	0	0	0	0	0
MAR R	18000	0	809	1500	0	65	1200	0	122	1	0	0
T	1	0	0	0	0	0	4	0	0	0	0	0
APR R	940	0	73	89	0	6	280	0	32	0	0	0
T	0	0	0	0	0	0	1	0	0			
MAY R	1300	0	60	25	0	1	260	0	24	0	0	0
T	1	0	0	0	0	0	1	0	0			
JUN R	390	0	18	8	0	0	180	0	10	0	0	0
T	6	0	0	0	0	0	2	0	0	0	0	0
JUL R	930	0	30	32	0	1	720	0	49	0	0	0
T	2	0	0	0	0	0	4	0	0	0	0	0
AUG R	510	0	30	35	0	3	270	0	26	0	0	0
T	1	0	0	0	0	0	3	0	0	0	0	0
SEP R	240	0	17	14	0	3	420	0	40	0	0	0
T	1	0	0	0	0	0	7	0	0			
OCT R	36000	0	578	4200	0	91	1700	0	88	0	0	0
T	1	0	0	1	0	0	2	0	0	0	0	0
NOV R	1900	2	213	980	0	61	450	0	89	0	0	0
T	0	0	0	0	0	0	1	0	0			
DEC R	7300	1	184	540	0	26	1100	0	55	0	0	0
T	0	0	0	0	0	0	2	0	0			

Note: (1) Sample Size = 100 ml (2) Sample Size = 1 ml

- Averages are rounded to the nearest whole number
- Blanks indicate no testing carried out.

WPOS - R. C. HARRIS WTP

	TOTAL COLIFORM (1)			FECAL COLIFORM (1)			STD. PLATE COUNT (2)			FECAL STREPTOCOCCUS (2)		
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN R	7600	2	377	420	0	18	11000	0	177	6200	0	494
T	2	0	0	0	0	0	4	0	0			
FEB R	22000	10	783	500	0	22	1300	2	107	160	0	10
T	0	0	0	0	0	0	4	0	0			
MAR R	1700	0	44	6	0	1	290	0	18	0	0	0
T	5	0	0	0	0	0	1	0	0			
APR R	600	0	50	10	0	1	160	1	17	0	0	0
T	0	0	0	0	0	0	1	0	0			
MAY R	1000	0	45	5	0	0	74	0	10	0	0	0
T	1	0	0	0	0	0	2	0	0			
JUN R	220	0	40	3	0	0	120	0	20	0	0	0
T	1	0	0	0	0	0	2	0	0			
JUL R	1600	0	58	7	0	1	380	0	29	26	0	2
T	3	0	0	0	0	0	2	0	0			
AUG R	2900	0	93	71	0	9	230	0	42	0	0	0
T	0	0	0	0	0	0	1	0	0			
SEP R	340	0	42	29	0	5	1600	0	55	0	0	0
T	2	0	0	0	0	0	2	0	0			
OCT R	2300	2	197	330	0	25	960	1	95	0	0	0
T	0	0	0	0	0	0	1	0	0			
NOV R	37000	2	1298	12000	0	329	2400	1	182	0	0	0
T	1	0	0	0	0	0	2	0	0			
DEC R	4500	0	261	300	0	18	930	2	97	0	0	0
T	1	0	0	0	0	0	2	0	0			

Note: (1) Sample Size = 100 ml (2) Sample Size = 1 ml

- Averages are rounded to the nearest whole number
- Blanks indicate no testing carried out.

WPOS - R. C. HARRIS WTP

	TOTAL COLIFORM (1)			FECAL COLIFORM (1)			STD. PLATE COUNT (2)			FECAL STREPTOCOCCUS (2)		
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN R	6400	1	438	1200	0	29	290	2	160	0	0	0
T	1	0	0	0	0	0	5	0	0			
FEB R	11000	0	405	600	0	30	220	0	30	0	0	0
T	1	0	0	0	0	0	4	0	1			
MAR R	11000	0	528	1100	0	39	2800	0	62	0	0	0
T	4	0	0	0	0	0	4	0	0			
APR R	4500	0	133	460	0	12	150	1	22	0	0	0
T	4	0	0	0	0	0	4	0	1			
MAY R	1500	0	166	110	0	9	2000	1	151	0	0	0
T	1	0	0	0	0	0	3	0	0			
JUN R	1100	0	102	38	0	3	850	0	26	0	0	0
T	5	0	0	0	0	0	3	0	0			
JUL R	910	2	62	52	0	2	250	6	36	0	0	0
T	3	0	0	0	0	0	5	0	0			
AUG R	4200	0	254	120	0	6	260	2	51	0	0	0
T	1	0	0	0	0	0	3	0	0			
SEP R	6000	1	180	85	0	5	480	0	55	0	0	0
T	2	0	0	0	0	0	3	0	0			
OCT R	730	1	95	25	0	4	1500	4	55	0	0	0
T	10	0	0	1	0	0	7	0	0			
NOV R	4100	9	227	120	0	10	370	6	55	0	0	0
T	0	0	0	0	0	0	4	0	0			
DEC R	1400	8	290	42	0	9	3700	3	115	0	0	0
T	1	0	0	0	0	0	4	0	0			

Note: (1) Sample Size = 100 ml (2) Sample Size = 1 ml

- Averages are rounded to the nearest whole number
- Blanks indicate no testing carried out.

TABLE 8.0: ONTARIO DRINKING WATER OBJECTIVES (TREATED WATER AT PLANT)

WPOS - R. C. HARRIS WTP

DATE	PARAMETER	MEASURED PARAMETER	GUIDELINE LIMIT	
Jun/85	Total Coliform	6	5	(1)
Oct/85	Fecal Coliform	1	0	(1)
Mar/84	Total Coliform	5	5	(1)
Jun/83	Total Coliform	5	5	(1)
Oct/83	Total Coliform	10	5	(1)
Oct/83	Fecal Coliform	1	0	(1)

NOTE: (1) MOE Drinking Water Objectives - Maximum Acceptable Concentration.

During the summer and autumn months of each year (July - Oct.), the temperature exceeded the guideline limit of 15°C.

APPENDIX B

FILTER BACKWASHING GUIDELINES AND PROCEDURE

FILTER BACKWASHING PROCEDURE

R.C. HARRIS WATER FILTRATION PLANT

1. Request FPO to start auto backwash pumps. (*)

2. Select filter No. 1 to 40 - no visible flow from influent valve - 96 hours or loss of head 1.5 m L.O.H. and flow in percentage calibration marked on tape at side of scale.

3. Check that the wash water tanks are full. When tanks are full, the backwash pumps shut off. When the level drops during the backwash, the pumps come back on automatically, based on the tank level.

4. Close influent valve. Filter until level reaches top of troughs. Close effluent valve or rate controller.

5. Place in service a clean filter with longest standing time for each filter removed from service - maintain flow rate. DO NOT OVERFLOW.

6. Open drain on filter to be washed. Note #3.

7. Open wash water valve for low wash, start surface wash for 2 minutes.

8. Open wash water valve for high wash and close surface wash valve. High wash 6 minutes.

9. Note surface of filter bed. When clear areas appear, close down wash water valve.

10. Close drain valve.

11. Open influent valve. 250 L/s - 5 MGD.

12. Open fully influent valve on washed filter and leave out of service at least 15 minutes.

NOTE: Non routine washing procedures will be dictated by the senior shift personnel.
Washing procedure must be adhered to unless authorized changed are put into effect by supervisor.
As filters being rehabilitated are returned to service they will be washed at 1.5 m L.O.H. or 72 hours.

* Auto backwash pump sequence is:

At time 00:30 - backwash pump #7 comes on.
At time 01:30 - backwash pump #6 comes on.
At time 02:30 - backwash pump #5 comes on.

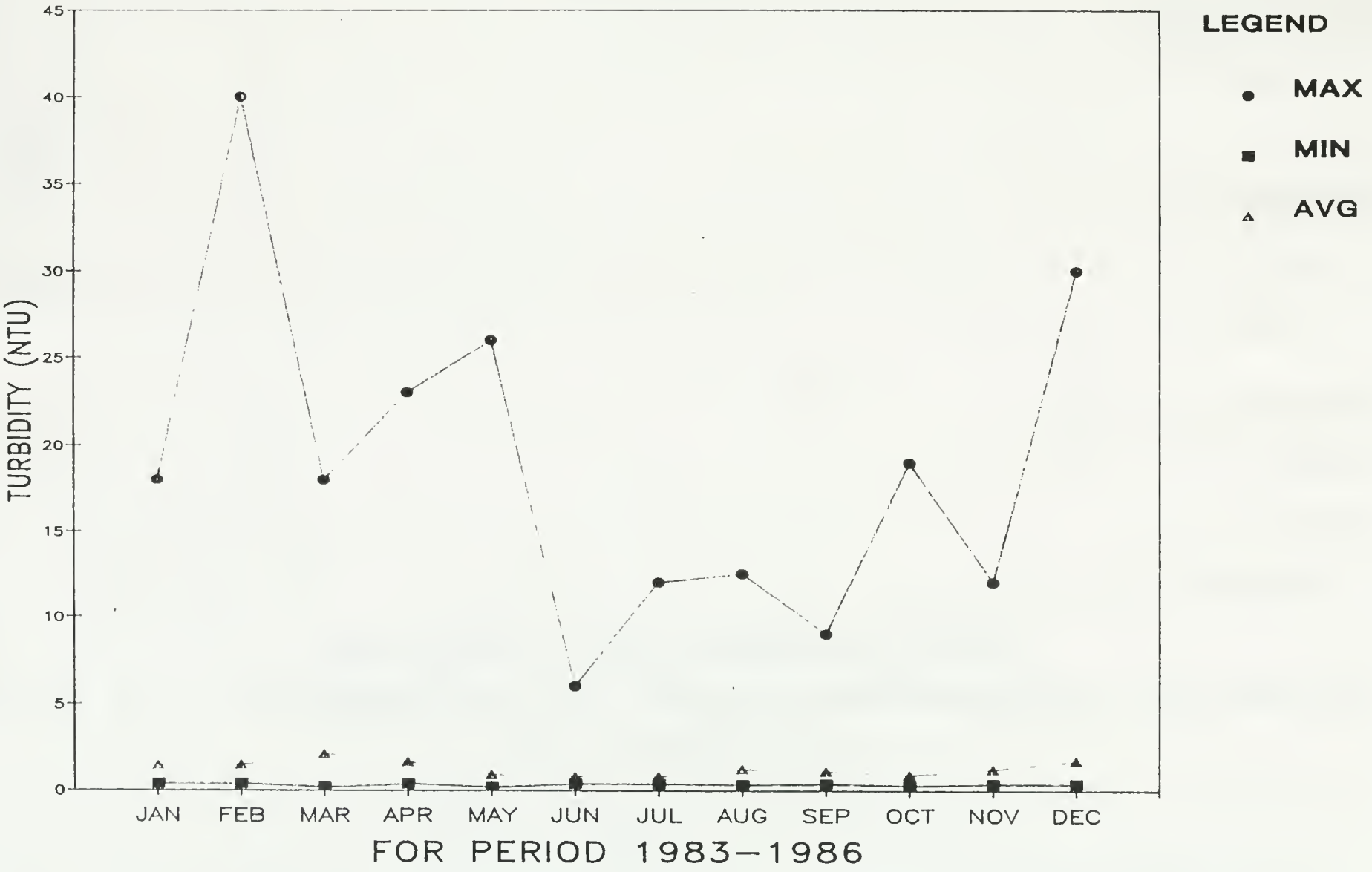
APPENDIX C

GRAPHICAL TURBIDITY DATA

R.C. HARRIS WTP

FIG. 1.0: COMPOSITE PROFILE

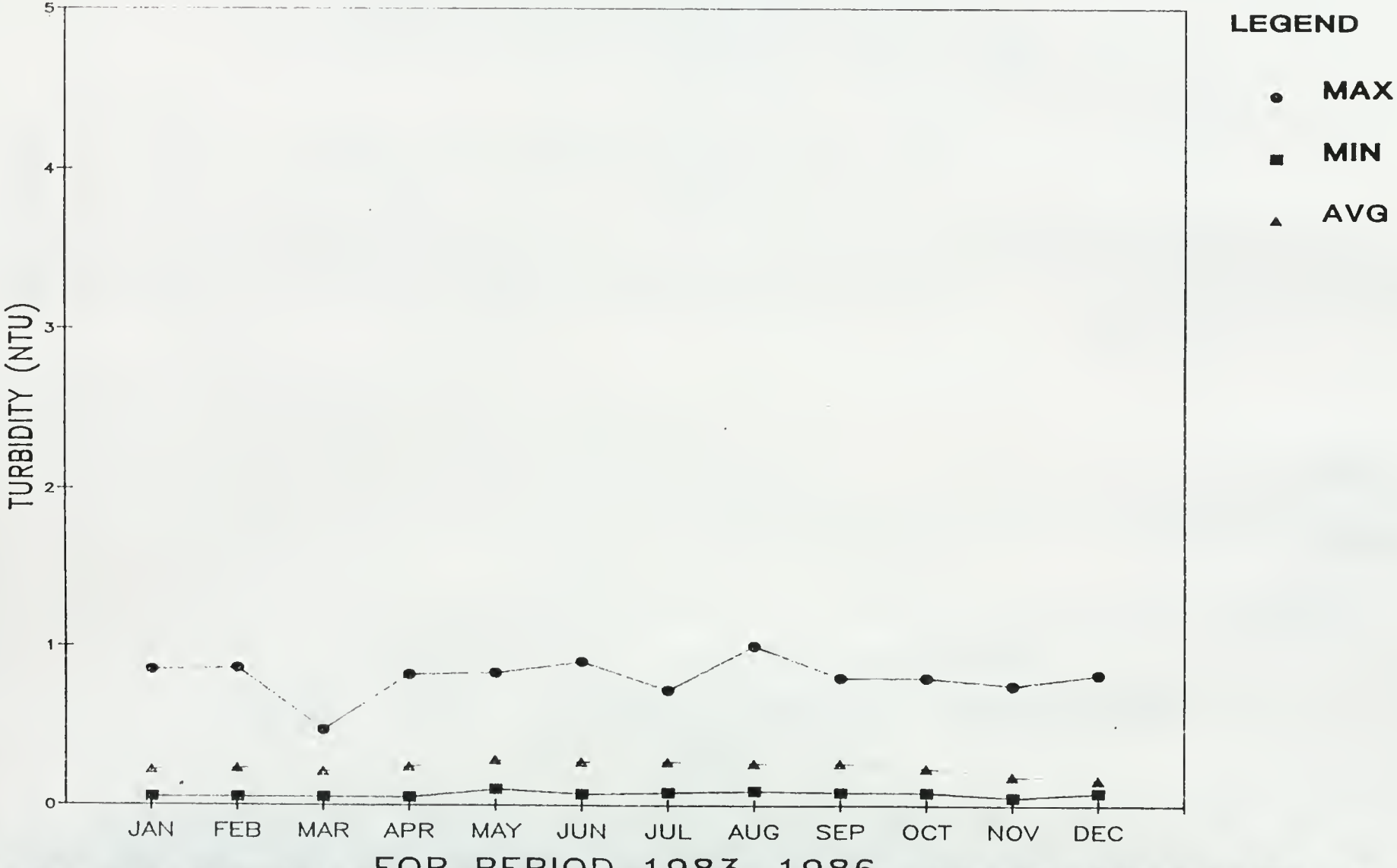
RAW WATER TURBIDITY RANGES



R.C. HARRIS WTP

FIG. 1.1: COMPOSITE PERFORMANCE PROFILE

TREATED WATER TURBIDITY RANGES

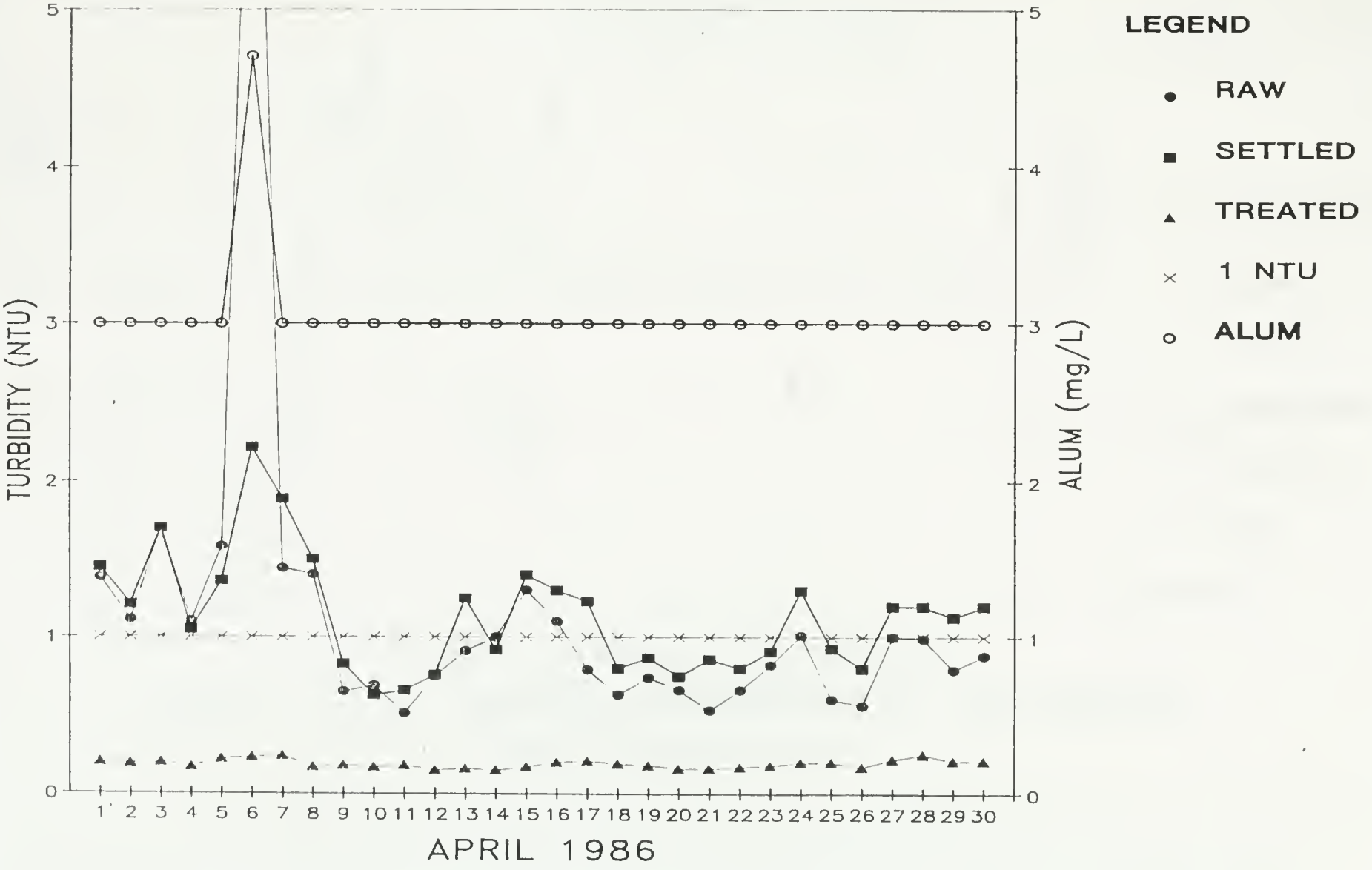


FOR PERIOD 1983–1986

R.C. HARRIS WTP

FIG. 2.0: PERFORMANCE PROFILE

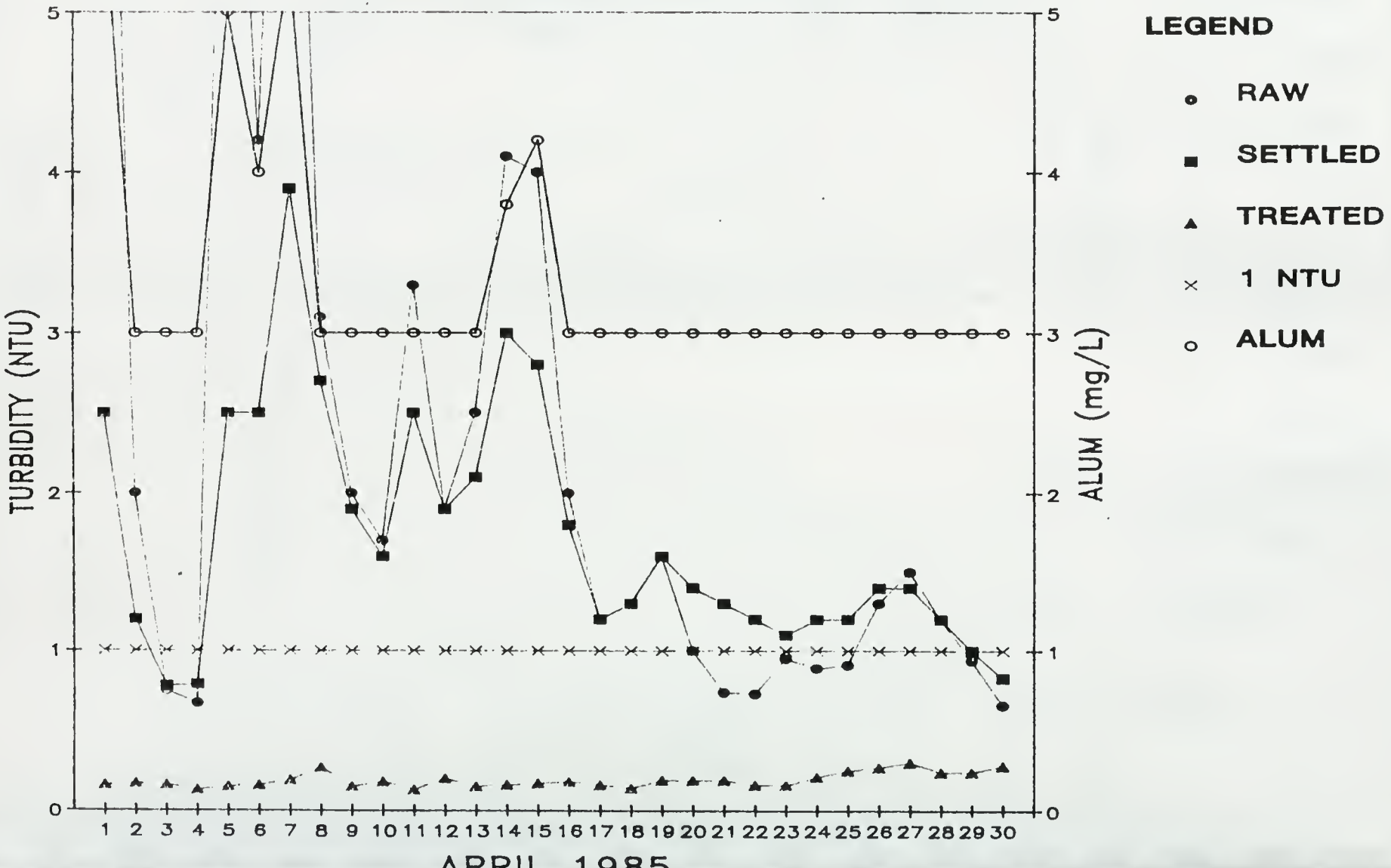
DAILY TURBIDITY READINGS



R.C. HARRIS WTP

FIG. 2.1: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS



APPENDIX D

JAR TESTING

R.C. HARRIS

Jar Test Procedure

The MSTS test procedure that was used for all testing carried out on R.C. Harris raw water was as follows:

1. Two hundred mL sample used.

2. Two minutes fast mix.

3. Thirty minutes flocculation mixing.

4. Thirty minutes settling time.

5. Filtration through a Whatman glass microfibre filter, followed by 1.2 µm filter.

The MSTS test procedure is a technique developed by Gore & Storrie Limited which has been shown to provide overall results similar to full scale conventional plant operations consisting of coagulation, flocculation, sedimentation and dual media filtration.

LABORATORY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
22 Nov./86	MOE Water Plant Optimization Study R.C. Harris Water Treatment Plant	380.64

SAMPLE NO. & DESCRIPTION

R.C. Harris Raw Water:

Sample No. 1 -
Typical raw water sample collected 19 Nov./86

Sample No. 2 -
Typical raw water sample collected 10 Sept./87

PARAMETERS	SAMPLE NO. 1	SAMPLE NO. 2	SAMPLE NO.	SAMPLE NO.
pH	7.40	7.95		
Colour (HCU)	<5	<5		
Turbidity (NTU)	0.65	1.9		
Alkalinity (mg/L as $CaCO_3$)	82	90		
Hardness (mg/L as $CaCO_3$)	140	132		
Iron (mg/L)				
Manganese (mg/L)				

COMMENTS

CONDUCTED BY

REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
22 Nov./86	MOE Water Plant Optimization Study R.C. Harris Water Treatment Plant	380.64

TEST DESCRIPTION

Removal of Turbidity with Alum
R.C. Harris Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	WATER QUALITY AFTER TREATMENT					
	Alum			pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Hard. (mg/L)	Al (mg/L)
1	3		4	7.38	0.19	<5			
2	6		3	7.36	0.11	<5	80	132	
3	10		3	7.30	0.10	<5	80	130	
4	15		4	7.28	0.18	<5			
5	20		4	7.28	0.23	<5			
6									
7									
RAW,UNTREATED				7.40	0.65	<5	82	140	

SAMPLE TEMPERATURE Start: 11°C Finish: 19°C

COMMENTS

COMMENTS

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY

REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
2 April/87	MOE Water Plant Optimization Study R.C. Harris Water Treatment Plant	380.64

TEST DESCRIPTION

Removal of Turbidity with Alum
R.C. Harris Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	WATER QUALITY AFTER TREATMENT					
	Alum			pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Hard. (mg/L)	Al (mg/L)
1	3		4	7.62	0.15	<5			
2	6		2-3	7.71	0.15	<5	86	130	
3	10		2	7.74	0.14	<5	86	130	
4	15		2	7.40	0.15	<5			
5	20		3	7.46	0.15	<5			
6									
7									
RAW, UNTREATED				8.05	1.5	5	82	140	

SAMPLE TEMPERATURE Start: 26.6°C Finish: 26.6°C

COMMENTS

COMMENTS

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY

REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
2 April/87	MOE Water Plant Optimization Study R.C. Harris Water Treatment Plant	380.64

TEST DESCRIPTION

Removal of Turbidity with Alum and Magnifloc 834A Polymer
R.C. Harris Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	WATER QUALITY AFTER TREATMENT					
	Alum	Poly 834A		pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Hard. (mg/L)	Al (mg/L)
1	3	0.1	4		0.14				
2	3	0.3	4		0.15				
3	3	0.5	4		0.15				
4	6	0.1	2	7.8	0.16	<5	86	130	
5	6	0.3	3		0.16				
6	6	0.5	3-4		0.26				
7									
RAW, UNTREATED				8.05	1.5	5	82	140	

SAMPLE TEMPERATURE Start: 10.5°C Finish: 26°C

COMMENTS

COMMENTS

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
3 April/87	MOE Water Plant Optimization Study R.C. Harris Water Treatment Plant	380.64

TEST DESCRIPTION

Removal of Turbidity with Alum and Magnifloc 587C Polymer
R.C. Harris Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	WATER QUALITY AFTER TREATMENT					
	Alum	Poly 587C		pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Hard. (mg/L)	Al (mg/L)
1	3	0.1	4		0.12	<5			
2	3	0.3	4		0.12	<5			
3	3	0.5	4		0.16	<5			
4	6	0.1	2	7.8	0.14	<5	86	132	
5	6	0.3	2		0.15	<5			
6	6	0.5	3		0.17	<5			
7									
RAW, UNTREATED				8.05	1.5	5	82	140	

SAMPLE TEMPERATURE Start: 4°C Finish: 22°C

COMMENTS

COMMENTS

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY

REVIEWED B

Gore & Storrie Limited TEST NO. 5

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
2 April/87	MOE Water Plant Optimization Study R.C. Harris Water Treatment Plant	380.64

TEST DESCRIPTION

Removal of Turbidity with Alum and Magnifloc 900N Polymer
R.C. Harris Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	WATER QUALITY AFTER TREATMENT					
	Alum	Poly 900N		pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Hard. (mg/L)	Al (mg/L)
1	3	0.1	4		0.13	<5			
2	3	0.3	4		0.14	<5			
3	3	0.5	4		0.14	<5			
4	6	0.1	2	7.54	0.14	<5	82	131	
5	6	0.3	2		0.15	<5			
6	6	0.5	3		0.16	<5			
7									
RAW, UNTREATED				8.05	1.5	5	82	140	

SAMPLE TEMPERATURE Start: 4°C Finish: 24°C

COMMENTS

COMMENTS

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY

REVIEWED BY

Gore & Storrie Limited TEST NO. 6

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
11 Sep./87	MOE Water Plant Optimization Study R.C. Harris Water Filtration Plant	380.64

TEST DESCRIPTION

Removal of Turbidity with Alum
1 Litre Jar Tests - R.C. Harris Raw Water Sample No. 2

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	(2) Alum			pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Hard. (mg/L)	Al (mg/L)
raw									
2	2		4-5	7.9	0.20	<<5	89	132	0.30
3	3		4	7.9	0.20	<<5	86	132	0.34
4	4		3	7.9	0.16	<<5	85	132	0.34
5	5		2-3	7.9	0.18	<<5	84	132	0.31
6	7		2	7.87	0.15	<<5	82	132	0.28
7	10		1-2	7.84	0.14	<<5	80	130	0.23
RAW, UNTREATED				7.95	1.9	<5	90	132	

SAMPLE TEMPERATURE Start: 22.5°C Finish: 22.5°C

COMMENTS

(1) Treatment Steps: Alum added; stirred at greater than 100 rpm for 2 minutes, 30 rpm for 30 minutes; settled for 30 minutes and filtered through a 1.2 mm membrane filter by vacuum filtration.

(2) Commercial grade equivalent $Al_2(SO_4)_3 \cdot 14H_2O$ added from a 10 mg/mL solution.

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY REVIEWED BY

Gore & Storrie Limited TEST NO. 7

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
17 Sep./87	MOE Water Plant Optimization Study R.C. Harris Water Filtration Plant	380.64

TEST DESCRIPTION

Removal of Turbidity with Alum
1 Litre Jar Tests - R.C. Harris Raw Water Sample No. 2

JAR NO.	CHEMICAL DOSAGES (mg/L) (2) Alum		FLOC RATING	WATER QUALITY AFTER TREATMENT (1) pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Hard. (mg/L)	Al (mg/L)
raw									
2	15		2-3	7.66	0.12	<<5	79	132	0.17
3	20		2	7.65	0.12	<<5	78	133	0.11
4	25		1-2	7.64	0.11	<<5	77	132	0.13
5	30		1	7.56	0.11	<<5	76	132	0.13
6	35		1-2	7.54	0.11	<<5	73	132	0.11
7	140		3	7.55	0.14	<<5	70	132	0.15
RAW, UNTREATED				7.95	1.9	<5	90	132	

SAMPLE TEMPERATURE Start: 22.5°C Finish: 22.5°C

COMMENTS

(1) Treatment Steps: Alum added; stirred at greater than 100 rpm for 2 minutes, 30 rpm for 30 minutes; settled for 30 minutes and filtered through a 1.2 mm membrane filter by vacuum filtration.

(2) Commercial grade equivalent $Al_2(SO_4)_3 \cdot 14H_20$ added from a 10 mg/mL solution.

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

APPENDIX E
DAILY RECORD

METROPOLITAN TORONTO DEPARTMENT OF WORKS

WATERWORKS DIVISION

RECORD OF FILTER OPERATION — R. C. HARRIS FILTRATION PLANT

FOR DAY ENDING MIDNIGHT THE DAY OF SEP 2 1 1987 19

FILTER NO / HOUR	1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		FILTER NO / HOUR
	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	
00 01																																							00 01
02 00																																							02 00
04 00																																							04 00
06 00																																							06 00
08 00																																							08 00
10 00																																							10 00
12 00																																							12 00
14 00																																							14 00
16 00																																							16 00
18 00																																							18 00
20 00																																							20 00
22 00																																							22 00
24 00																																							24 00
AVERAGE																																							AVERAGE

FILTER NO / HOUR	21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		FILTER NO / HOUR
	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	RATE	LOSS OF HEAD	
00 01																																							00 01
01 00																																							01 00
03 00																																							03 00
05 00																																							05 00
07 00																																							07 00
09 00																																							09 00
11 00																																							11 00
13 00																																							13 00
15 00																																							15 00
17 00																																							17 00
19 00																																							19 00
21 00																																							21 00
23 00																																							23 00
24 00																																							24 00
AVERAGE																																							AVERAGE

EFFLUENT VENTURI METERS

HOUR	WEST RATE	WEST COUNTER	EAST RATE	EAST COUNTER
00 01				
02 00				
04 00				
06 00				
08 00				
10 00				
12 00				
14 00				
16 00				
18 00				
20 00				
22 00				
24 00				

WATER ELEVATIONS

HOUR	S W CONDUITS	F W RESERVOIR
00 01		
02 00		
04 00		
06 00		
08 00		
10 00		
12 00		
14 00		
16 00		
18 00		
20 00		
22 00		
24 00		

FILTER BACKWASH

HOUR	WEST FILTER NO	WEST START	WEST FINISH	WEST IN SERVICE	EAST FILTER NO	EAST START	EAST FINISH	EAST IN SERVICE
00 01								
02 00								
04 00								
06 00								
08 00								
10 00								
12 00								
14 00								
16 00								
18 00								
20 00								
22 00								
24 00								

MASTER RATE CONTROL

WEST HOUR	WEST RATE

EAST HOUR	EAST RATE

SERVICE RECORD

IN HOUR	IN NO	OUT HOUR	OUT NO

TOTAL FILTERED DURING DAY

WEST

EAST

TOTAL

REMARKS

00 01 To 08 00 — Plant Operator 4 — Plant Operator 4

08 00 To 16 00 — Plant Operator 4 — Plant Operator 4

16 00 To 24 00 — Plant Operator 4 — Plant Operator 4

Works Supervisor

METROPOLITAN TORONTO – DEPARTMENT OF WORKS

WATER SUPPLY DIVISION

RECORD OF GASEOUS CHEMICAL TREATMENT – FILTRATION PLANT

DATE– _____

TIME	PRE-CHLORINATION						POST-CHLORINATION							DECHLORINATION						AMMONIA		TASTE		RESIDUAL CHLORINE – mg/L				
	RAW WATER $10^3 m^3/d$	DOSAGE mg/L	METER SETTING kg/d	SCALE WT/kg No.	SCALE WT/kg No.	USED kg/h	FILT'D WATER	DOSAGE mg/L	DOSAGE (FLD TIME CHANGE)	METER SETTING kg/d No.	METER SETTING kg/d No.	SCALE WEIGHT/kg No.	SCALE WEIGHT/kg No.	USED kg/h No.	USED kg/h No.	FLOW RATE $10^3 m^3/d$	SULPHUR DIOXIDE DOSAGE mg/L	SULPHUR DIOXIDE METER SET. kg/d	SULPHUR DIOXIDE SCALE WT/kg No.	SULPHUR DIOXIDE SCALE WT/kg No.	SULPHUR DIOXIDE USED kg/h	DOSAGE mg/L	SETTING kg/d	FILT'D.	OUTPUT	TAP 3 FILT.	TAP 4 AFTER POST Cl_2	TAP 5 BEFORE SO_2	TAP 6 AFTER SO_2	TAP 7 OUT

CHLORINE CONTAINERS						
SCALE No	NUMBER	WEIGHT GROSS	WEIGHT TARE	FULL	IN USE	EMPTY

SULPHUR DIOXIDE CONTAINERS						
SCALE No	NUMBER	WEIGHT GROSS	WEIGHT TARE	FULL	IN USE	EMPTY

AMMONIA STORAGE TANKS				
TANK No.	IN USE	VOLUME 2400	DELIVERY BEFORE	DELIVERY AFTER

OPERATOR:

0000-0800 – _____

0800-1600 – _____

1600-2400 – _____

REMARKS: _____

METROPOLITAN TORONTO — DEPARTMENT OF WORKS

WATER SUPPLY DIVISION

PLANT CHEMICAL SAMPLE RECORD

DATE _____

TIME	COLL-ECTOR	$FeCl_3$ mg/L	AM-MONIA mg/L	CHLOR. mg/L		TEMP. °C	WIND	pH	TURBIDITY F.T.U.				FREE AMMONIA				FILTRATION RATE ML/d
				PRE	POST	RAW		RAW	RAW	SETT.	FILT.	OUT	RAW	SETT.	BEFORE NH_3	OUT	
TOTAL																	
MAX.																	
MIN.																	
AVE.																	
Nº S.																	

REVISED WS – 18

METROPOLITAN TORONTO—DEPARTMENT OF WORKS

WATER SUPPLY DIVISION

ALUM RECORD—R.C. HARRIS FILTRATION PLANT

PERIOD ______________

DATE ______________ DAY ______________ 19____

TIME	WATER TREATED 10^3 m^3	DOSAGE mg/L	ROTAMETER NO. ____ SETTING mm	SET AMT. DOSED m^3 / d

TOTAL WATER TREATED ______________ $10^3 m^3$

INVENTORY

PERIOD ________ DAY ________ 19____

	TANK NO. 1	TANK NO 2	
AT BEGINNING	____	____	L
CONSUMED	____	____	L
	____	____	L
RECEIVED	____	____	L
AT END	____	____	L
		____	L
TOTAL		____	L

REMARKS

TOTAL WATER TREATED

CHIEF OPERATOR

00.01 – 08.00 __________

08.00 – 16.00 __________

16.00 – 24.00 __________

WORKS SUPERVISOR

____

W.S. 2

R.C. HARRISER

GASEOUS CHEMICAL EQUIPMENT OPERATION

DATE: _____

CHLORINE

EVAPORATORS

TIME	#1 Scale	#1 Press	#1 Temp.	#2 Scale	#2 Press	#2 Temp.	#3 Scale	#3 Press	#3 Temp.	#4 Scale	#4 Press	#4 Temp.	#5 Scale	#5 Press	#5 Temp.
0001															
0100															
0200															
0300															
0400															
0500															
0600															
0700															
0800															
0900															
1000															
1100															
1200															
1300															
1400															
1500															
1600															
1700															
1800															
1900															
2000															
2100															
2200															
2300															
2400															

CHLORINATORS

TIME	#1 Evap.	#1 Gas Pr.	#1 Vacuum	#1 Control	#2 Evap.	#2 Gas Pr.	#2 Vacuum	#2 Control	#3 Evap.	#3 Gas Pr.	#3 Vacuum	#3 Control	#4 Evap.	#4 Gas Pr.	#4 Vacuum	#4 Control	#5 Evap.	#5 Gas Pr	#5 Vacuum	#5 Control
0001																				
0100																				
0200																				
0300																				
0400																				
0500																				
0600																				
0700																				
0800																				
0900																				
1000																				
1100																				
1200																				
1300																				
1400																				
1500																				
1600																				
1700																				
1800																				
1900																				
2000																				
2100																				
2200																				
2300																				
2400																				

SULPHUR DIOXIDE

EVAPORATORS

TIME	#1 Scale	#1 Press	#1 Temp.	#2 Scale	#2 Press	#2 Temp.	#3 Scale	#3 Press	#3 Temp.
0001									
0100									
0200									
0300									
0400									
0500									
0600									
0700									
0800									
0900									
1000									
1100									
1200									
1300									
1400									
1500									
1600									
1700									
1800									
1900									
2000									
2100									
2200									
2300									
2400									

SULPHONATORS

TIME	#1 Evap.	#1 Gas Pr.	#1 Vacuum	#1 Control	#2 Evap.	#2 Gas Pr.	#2 Vacuum	#2 Control	#3 Evap.	#3 Gas Pr.	#3 Vacuum	#3 Control
0001												
0100												
0200												
0300												
0400												
0500												
0600												
0700												
0800												
0900												
1000												
1100												
1200												
1300												
1400												
1500												
1600												
1700												
1800												
1900												
2000												
2100												
2200												
2300												
2400												

AMMONIA

AMMONIATORS

TIME	#1 Tank	#1 Gas Pr.	#1 Vacuum	#1 Control	#2 Tank	#2 Gas Pr.	#2 Vacuum	#2 Control
0001								
0100								
0200								
0300								
0400								
0500								
0600								
0700								
0800								
0900								
1000								
1100								
1200								
1300								
1400								
1500								
1600								
1700								
1800								
1900								
2000								
2100								
2200								
2300								
2400								

OPERATORS

00.01–08:00 Hrs. _____
08:00–16:00 Hrs. _____
16:00–24:00 Hrs. _____

WATER	PRESSURE
03:00 Hrs.	15:00 Hrs
07:00 Hrs.	19:00 Hrs
11:00 Hrs.	23:00 Hrs

WATER METER
WEST 24:00 _____
EAST 24:00 _____

REMARKS:

AMMONIA STORAGE TANK

13:00	#1	#2	#3
Press.			
Volume			

METROPOLITAN TORONTO - DEPARTMENT OF WORKS

WATER SUPPLY DIVISION

FLUORIDATION RECORD, _____

FOR DAY ENDING MIDNIGHT ON _____ THE _____ DAY OF _____, 19__

TIME	DAY TANK WEIGHT kg	DAY TANK RATE kg/h	FLOW METER INTEGRATOR m^3	TREATMENT RATE m^3/h	DOSAGE RATE (mg/L) FROM CHART	EQUIPMENT CHECK	SAMPLE TAKEN
00:01							
01:00							
02:00							
03:00							
04:00							
05:00							
06:00							
07:00							
08:00							
09:00							
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							
19:00							
20:00							
21:00							
22:00							
23:00							
24:00							
TOTALS & AVERAGE							

REMARKS:

LOSS IN WEIGHT INVENTORY

(TO BE COMPILED BY CHIEF CHEMIST)

ON HAND BEGINNING OF PERIOD _____ kg

RECEIVED DURING PERIOD _____ kg

GROSS TOTAL _____ kg

CONSUMED DURING PERIOD _____ kg

ON HAND END OF PERIOD _____ kg

PHYSICAL INVENTORY _____ HOURS

STORAGE TANKS

Nº 1 _____ m^3 Nº 2 _____ m^3

DAY TANK _____ kg

ENTERED BY _____

DAY TANK FILLING

TIME										
INITIAL WT. kg										
FINAL WT kg										

PLANT OPERATORS			TANKS IN USE									
00:01 - 08:00	08:00 - 16:00	16:00 - 24:00		DAY TANK								
				STOR TANK								

PLANT SUPER - CH OPER

CH CHEMIST - CHEMIST

METROPOLITAN TORONTO - DEPARTMENT OF WORKS

WATER SUPPLY DIVISION

AMMONIATION [redacted] RECORD, _____

FOR DAY ENDING MIDNIGHT ON _____ THE _____ DAY OF _____, 19__

TIME	DAY TANK WEIGHT kg	DAY TANK RATE kg/h	FLOW METER INTEGRATOR m^3	TREATMENT RATE m^3/h	DOSAGE RATE (mg/L) FROM CHART	EQUIPMENT CHECK	SAMPLE TAKEN
00:01							
01:00							
02:00							
03:00							
04:00							
05:00							
06:00							
07:00							
08:00							
09:00							
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							
19:00							
20:00							
21:00							
22:00							
23:00							
24:00							
TOTALS & AVERAGE							

REMARKS:

LOSS IN WEIGHT INVENTORY

(TO BE COMPILED BY CHIEF CHEMIST)

ON HAND BEGINNING OF PERIOD _____ kg

RECEIVED DURING PERIOD _____ kg

GROSS TOTAL _____ kg

CONSUMED DURING PERIOD _____ kg

ON HAND END OF PERIOD _____ kg

PHYSICAL INVENTORY 24:00 HOURS

STORAGE TANKS

№ 1 _____ m^3 № 2 _____ m^3

DAY TANK _____ kg

№ 3 _____ m^3 № 4 _____ m^3

ENTERED BY _____

DAY TANK FILLING

TIME																							
INITIAL WT kg																							
FINAL WT kg																							

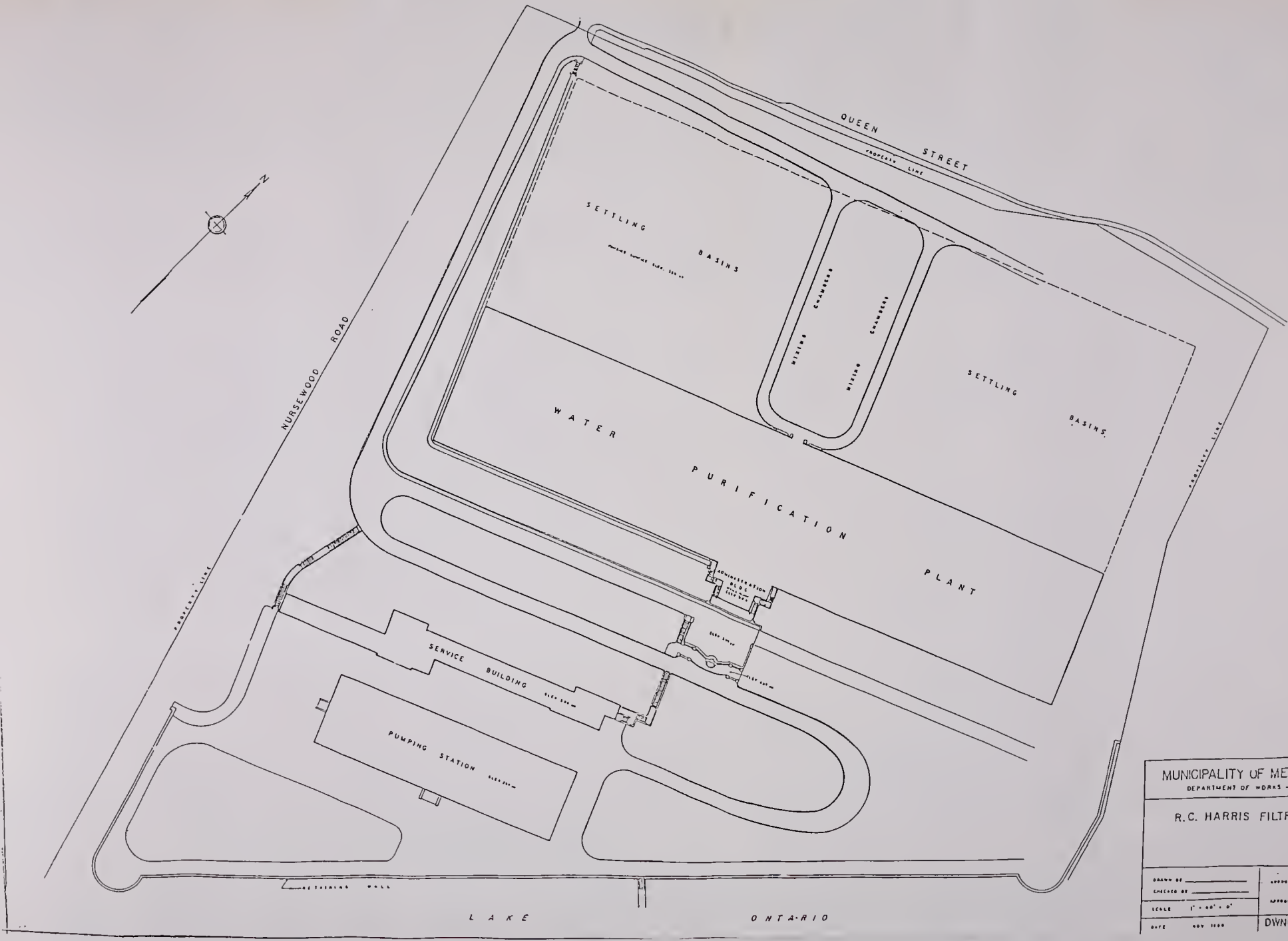
PLANT OPERATORS			TANKS IN USE	
00:01 - 08:00	08:00 - 16:00	16:00 - 24:00		DAY TANK
				STOR TANK

PLANT SUPER — CH OPER CH CHEMIST — CHEMIST

WS 16

APPENDIX F

DRAWINGS



MUNICIPALITY OF METROPOLITAN TORONTO
DEPARTMENT OF WORKS - WATER WORKS DIVISION

R.C. HARRIS FILTRATION PLANT

DRAWN BY
CHECKED BY
APPROVED BY
APPROVED BY
SCALE 1" = 60' - 0"
DATE NOV 1960
DWNG N° 28-124

FROM LAKE ONTARIO

FLOW PARAMETERS BASED ON 1000 ML/d

INTAKE
- TWO 2450 mm DIAMETER CONCRETE LINED STEEL INTAKE PIPES, 2850 METERS LONG.
- EACH INTAKE PIPE DISCHARGES INTO A 3050 mm DIAMETER INTAKE TUNNEL IN ROCK BELOW THE LAKEBED.
THIS TUNNEL IS 1000 METERS LONG AND TERMINATES AT THE SURGE WELL.

PRECHLORINATION
- 3 WALLACE AND TIERNAN EVAPORATORS
- 1 SCALE FOR TWO 0.9 TONNE CONTAINERS
- CHLORINATORS – SEE POST CHLORINATION
- DOSAGE = 0.8 mg/L (FIXED)

INTAKE WELL
- CONCRETE WELL 13.0 m x 4.9 m x 9.7 m DEEP.

ALUM
- 2 CONCRETE STORAGE TANKS, CAPACITY = 90300 L EACH
- GRAVITY FEED BY ROTAMETER
- 3 PULSA MODEL NO. 7880 METERING PUMPS, MAX. CAPACITY = 11.8 L/Min. EACH (METERING PUMPS ARE NOT CURRENTLY IN USE, BUT ARE EXPECTED TO BE BY THE END OF 1987)
- DOSAGE RANGE: 3–10 mg/L
- EQUIPMENT CAPACITY: 0–22 mg/L

TRAVELLING WATER SCREENS
- EIGHT TRAVELLING WATER SCREENS, 1.8 METERS WIDE AND 10 METERS DEEP.
- BRASS WIRE MESH WITH 13 mm SQUARE OPENINGS.

RAW WATER PUMPING STATION

NO.	TYPE	CAPACITY (ML/d)
1	ELECTRIC	115.0
1	ELECTRIC	180.0
1	ELECTRIC	230.0
3	ELECTRIC	275.0 EACH
	TOTAL INSTALLED	1330.0
	FIRM CAPACITY	1075.0

FUTURE ALUM APPLICATION POINT

FLOCCULATION
HYDRAULIC SPIRAL FLOW FLOCCULATION TANKS
- 30 TANKS HAVE DIM. 6.53 m x 6.40 m x 7.31 m DEEP
- 18 TANKS HAVE DIM. 6.43 m x 6.40 m x 7.31 m DEEP
- 18 TANKS HAVE DIM. 6.07 m x 6.40 m x 7.31 m DEEP
- 6 TANKS HAVE DIM. 5.97 m x 6.40 m x 7.31 m DEEP

DETENTION TIME AT 1000 ML/d = 31 min.

SETTLING TANKS
- HORIZONTAL CROSS-FLOW SETTLING TANKS
- 2 TANKS – NOMINAL SIZE 91.2 m x 25.9 m x 7.3 m DEEP
  - OVERFLOW RATE AT 1000 ML/d = 2.9 m/h
  - DETENTION TIME AT 1000 ML/d = 149 min.
- 2 TANKS – NOMINAL SIZE 91.2 m x 27.4 m x 7.3 m DEEP
  - OVERFLOW RATE AT 1000 ML/d = 2.8 m/h
  - DETENTION TIME AT 1000 ML/d = 158 min.
- 2 TANKS – NOMINAL SIZE 91.2 m x 27.1 m x 7.3 m DEEP
  - OVERFLOW RATE AT 1000 ML/d = 2.8 m/h
  - DETENTION TIME AT 1000 ML/d = 156 min.

SLUDGE TO LAKE ONTARIO

FILTERS
- FORTY FILTERS – NOMINAL SIZE 20.7 m x 9.0 m
- FILTRATION RATE = 5.8 m/h AT 1000 ML/d
- TWENTY DUAL MEDIA FILTERS IN EAST SECTION OF PLANT CONTAIN 305 mm OF ANTHRACITE, 305 mm OF SAND AND 380 mm OF GRAVEL
- TWENTY DUAL MEDIA FILTERS IN WEST SECTION OF PLANT CONTAIN 254 mm OF ANTHRACITE, 254 mm OF SAND AND 508 mm OF GRAVEL

POST CHLORINATION
- TWO WALLACE AND TIERNAN EVAPORATORS
- FOUR 3500 kg/d CHLORINATORS
- ONE 1400 kg/d CHLORINATOR
(CHLORINATORS ARE NOT DEDICATED AND CAN FEED CHLORINE TO ANY OF THE THREE CHLORINATION POINTS.)
- TWO SCALES FOR THREE 0.9 TONNE CONTAINERS EACH
- ONE SCALE FOR TWO 0.9 TONNE CONTAINERS (STANDBY)
- DOSAGE RANGE: 0.2–10.0 mg/L

COMMON CHEMICAL APPLICATION POINT (RESERVOIR INLET)

FLUORIDE
- FOUR STORAGE TANKS CAPACITY OF TANKS 1 AND 2 = 22603 L EACH CAPACITY OF TANKS 3 AND 4 = 25100 L EACH
- 2 DAY TANKS, CAPACITY OF EACH = 790 L
- 2 WALLACE AND TIERNAN METERING PUMPS
- DOSAGE RANGE: 0.80–1.15 mg/L
- EQUIPMENT CAPACITY: 0–3.3 mg/L

RESERVOIR
- CAPACITY = 55.0 ML

BACKWASHING
THERE ARE TWO 0.33 ML ELEVATED BACKWASH TANKS
THERE ARE THREE BACKWASH PUMPS

NO.	CAPACITY (ML/d)
1	45.0
1	34.0
1	23.0
TOTAL INSTALLED	102.0
FIRM CAPACITY	57.0

SULPHUR DIOXIDE
- THREE WALLACE AND TIERNAN EVAPORATORS
- ONE 3500 kg/d SULPHONATOR
- ONE 1920 kg/d SULPHONATOR
- ONE 1300 kg/d SULPHONATOR
- TWO SCALES FOR THREE 0.9 TONNE CYLINDERS
- DOSAGE RANGE: 0.15–4.2 mg/L
- EQUIPMENT CAPACITY: 0–8.7 mg/L

AMMONIA
- FOUR STORAGE TANKS, CAPACITY OF EACH = 8500 L
- TWO DAY TANKS ON SCALES, CAPACITY OF EACH = 850 kg
- TWO PULSA MODEL NO. 7120 METERING PUMPS, MAX. CAPACITY = 1.8 L/Min. EACH
- DOSAGE RANGE: 0.05–0.5 mg/L
- EQUIPMENT CAPACITY: 0–1.8 mg/L

FINAL CHLORINATION
- NOT NORMALLY USED
- THIS CHLORINATION POINT CAN BE FED USING ANY OF THE CHLORINATORS

TREATED WATER PUMPING STATION

NO.	TYPE	CAPACITY (ML/d)
3	ELECTRIC	90.7 EACH
2	ELECTRIC	95.5 EACH
4	ELECTRIC	113.6 EACH
	TOTAL INSTALLED	917.5
	FIRM CAPACITY	803.9

TUNNEL TO JOHN ST. AND PARKDALE PUMPING STATIONS

TO DISTRIBUTION SYSTEM

R.C. HARRIS W.T.P.
BLOCK FLOW SCHEMATIC
SEPTEMBER 1987

APPENDIX G

PROCEDURE FOLLOWING POSITIVE BACTERIOLOGICAL RESULTS

PROCEDURE FOLLOWING POSITIVE BACTERIOLOGICAL RESULTS
R.C. HARRIS WATER TREATMENT PLANT

When positive total coliforms counts, elevated standard plate counts, or the presence of background counts on coliform plates occur in output (treated) water samples, the following steps are implemented. Each situation is examined individually, and more action may be taken, depending on the situation.

1. A portion of the original output sample is tested for fecal coliforms.

2. A sample from the Before Sulphur Dioxide (SO_2) sample point is tested for standard plate count and total coliform.

3. The sample blanks and the bacteriological run for the day is reviewed for possible problems.

4. When possible, confirmation is sought from distribution samples collected at the same time.

5. Another output sample point may be tested to check for any sample point problems.

6. Plant operating records are reviewed for possible occurances which may explain the positive counts.

7. If positive counts continue, modifications to the treatment process may occur, and an investigation into the cause of the counts is undertaken.

APPENDIX H

OPERATING INSTRUCTIONS MANUAL
TABLE OF CONTENTS

ALUM

PAGE	SUBJECT
AL - 1	Turbidity - Sampling Schedule
AL - 2	Turbidity Meters - Calibration
AL - 3	Rotameter No. 1
AL - 4	Alum Application
AL - 5	
AL - 6	Retention Table

AMMONIA

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AM - 3	Ammonia Operation

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BACTERIOLOGICAL

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B - 2	Bacteriological - Collection of Sample
B - 3	Raw Water Bacteriological Samples

CHLORINE

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M - 2	Windscope Speed and Direction
M - 3	Operating and Calibrating Instructions for "Taylor Windscope"
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M - 7	Restart of Filters and Flocculation - Sedimentation Tanks
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R - 1	Radiation Samples
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SAFETY

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TERMS OF REFERENCE

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE

Purpose

To review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate materials and disinfection processes.

Work Tasks

1. Receive a package of available information on the plant from the MOE. Review the information provided and meet with the MOE staff to discuss the project.

2. Document the quality and quantity of raw and treated waters. Along with Work Task 3, send a progress report to the Project Committee at the conclusion of this work.

3. Define the present treatment processes and operating procedures. Along with Work Task 2, send a progress report to the Project Committee at the conclusion of this work.

4. Assess methods of efficient particulate removal which would utilize the present major capital works of the plant. Evaluate the particulate removal efficiency and sensitivity of operation, assuming optimum performance of the plant. Along with Work Task 5, send a progress report to the Project Committee at the conclusion of this work.

5. Assess methods which would improve, if necessary, the disinfection practices of the plant, keeping in mind a desire to minimize the production of chlorinated by-products in the treated water. Along with Work Task 4, send a progress report to the Project Committee at the conclusion of this work.

6. Describe possible short and long-term process modifications to obtain optimum disinfection and contaminant removal, with emphasis on particulate removal and a desire to minimize the production of chlorinated by-products. Meet with the Project Committee at the conclusion of this work to review the report information.

7. Prepare 7 copies of the draft report and submit to the Project Committee.

8. Review the Project Committee's comments and prepare 25 copies of the final report.

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE - WORK TASK NO. 1

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1. RECEIVE A PACKAGE OF AVAILABLE INFORMATION ON THE PLANT FROM THE MOE. REVIEW THE INFORMATION PROVIDED AND MEET WITH THE MOE STAFF TO DISCUSS THE PROJECT.

Elements of Work

(a) Receive a package of available information from the MOE concerning the plant.

(b) Review the information and otherwise prepare for a meeting to initiate work on the project, including preparation of a schedule of manpower and staff requirements.

(c) Meet with the MOE to discuss the available data, the terms of reference, and the project staff and work schedule.

2. DOCUMENT THE QUALITY AND QUANTITY OF RAW AND TREATED WATERS. ALONG WITH WORK TASK 3, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Tabulate the daily raw and treated water flows for the last three consecutive years.

(b) Document the methods of measuring the raw and treated water flow rates, and assess the validity of the records.

(c) Prepare a monthly summary of maximum, minimum, and average flows for the three years. Address any discrepancies which exist between raw and treated flow rates.

(d) Review and assess the monthly maximum, minimum, and average per capita flow for the three years. Compare the plant data with typical per capita flows for the local region.

(e) Document a summary, based on at least three years of data, of the raw and treated water quality testing data for physical, microbiological, radiological, and chemical water quality information. Document as much data as is needed to show possible seasonal trends in water quality. Where possible, show corresponding sets of raw and treated water quality information. Document the source and methods used in determining all water quality information. Assess the validity of the data, comparing plant and outside laboratory data.

(f) Tabulate, for the last three consecutive years, where available, raw and treated water turbidity, residual aluminum, pH, and colour. Record other data, such as particle counting, suspended solids, and algae counting, which could reflect on particulate removal efficiency. These data should be used for assessment of the particulate removal efficiency of the plant. Document the source and methods used in determining all information. A comparison should be made between the plant and outside laboratory information to ascertain the relative validity of the data. For plant data, emphasis should be given to plant laboratory tests rather than continuous process control instruments.

(g) Tabulate, for the last three consecutive years, the raw water bacterial test information at the plant. Also tabulate the corresponding treated water tests at the plant which register positive results. Document the source and methods used for all data provided. This information should be used to assess the effectiveness of the disinfection practices at the plant.

(h) Identify and recommend other water quality concerns, not related to particulate removal or disinfection, which should be considered as part of the assessment phase of this evaluation program.

(i) Submit a progress report to the Project Committee.

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE - WORK TASK NO. 3

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3. DEFINE THE PRESENT TREATMENT PROCESSES AND OPERATING PROCEDURES. ALONG WITH WORK TASK 2, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSIONS OF THIS WORK.

Elements of Work

(a) Where drawings are available, assemble sufficient record drawings, of a reduced size, to document the general site layout and the interrelationship of major plant components. If not already available, prepare a process and piping diagram (PAPD) of the plant operations.

(b) Prepare a simplified block schematic of the major plant components.

(c) Prepare a photographic record of the plant facilities, illustrating all of the major plant components and chemical feed systems.

(d) Tabulate the design parameters for all of the major plant components, with emphasis on the process operations, including chemical feeds. This information, as a minimum, must be consistent with the DWSP Questionnaire and must be confirmed and verified by field observations.

(e) Prepare a brief summary of how the plant is operated, including chemical dosage control, such as jar testing information, filter backwashing procedures and initiation, and pumping and flow control.

(f) Document and assess any reported problems in plant operations and/or in the distribution system related to water quality.

(g) Tabulate the daily average chemical dosages for the last three consecutive years. Document the methods used to evaluate chemical dosages and establish the validity of the dosage information provided.

With regard to disinfection, tabulate the dosages of chlorine and disinfection-related chemicals such as chlorine dioxide. In addition, provide corresponding data on disinfectant residuals in the plant, such as free and total chlorine residuals. Also, provide chlorine demand tests where available. Again, document the methods of dosage evaluation and residual measurements, and establish the validity of the data provided.

(h) Submit a progress report to the Project Committee.

4. ASSESS METHODS OF EFFICIENT PARTICULATE REMOVAL WHICH WOULD UTILIZE THE PRESENT MAJOR CAPITAL WORKS OF THE PLANT. EVALUATE THE PARTICULATE REMOVAL EFFICIENCY AND SENSITIVITY OF OPERATION, ASSUMING OPTIMUM PERFORMANCE OF THE PLANT. ALONG WITH WORK TASK 5, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Using information provided in Work Tasks 1 and 2, evaluate the plant's particulate removal efficiency. The basis of minimum particulate removal should be 1.0 FTU, which is the maximum acceptable concentration of the Ontario Drinking Water Objectives (Table 1, page 2, Ontario Ministry of the Environment, Revised 1983). It should, however, be recognized that it is desirable to strive for an operational level which is as low a turbidity level as is achievable.

(b) Conduct an evaluation of possible optimum performance alternatives, including jar testing of plant water samples.

(c) Evaluate the feasibility of optimum removals using the existing plant capital works. This evaluation should consider the worst case water quality conditions, even though field testing data may not be available during the initial phase of the study (see Work Task 7).

(d) Describe the operational procedures, management strategies, and equipment required for various feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation of the alternatives.

(e) Submit a progress report to the Project Committee.

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE - WORK TASK NO. 5

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5. ASSESS METHODS WHICH WOULD IMPROVE, IF NECESSARY, THE DISINFECTION PRACTICES OF THE PLANT, KEEPING IN MIND A DESIRE TO MINIMIZE THE PRODUCTION OF CHLORINATED BY-PRODUCTS IN THE TREATED WATER. ALONG WITH WORK TASK 4, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Using the information provided in Work Tasks 1 and 2, evaluate the plant's ability to disinfect the water. The basis of minimum disinfection should be to ensure a water quality as described in the Ontario Drinking Water Objectives (Ontario Ministry of the Environment, Revised 1983).

(b) Conduct an evaluation of possible optimum disinfection procedures for the plant, with consideration also given to the reduction of chlorinated by-products in the treated water.

(c) Evaluate the feasibility of the various alternatives using the existing plant capital works. Estimate the initial and final levels of chlorinated by-products for the various alternatives. Assess the relative merits of the alternatives.

(d) Describe the operational procedures, management strategies, and equipment required for the feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation for the alternatives.

(e) Submit a progress report to the Project Committee.

6. DESCRIBE POSSIBLE SHORT AND LONG-TERM PROCESS MODIFICATIONS TO OBTAIN OPTIMUM DISINFECTION AND CONTAMINANT REMOVAL, WITH EMPHASIS ON PARTICULATE REMOVAL AND A DESIRE TO MINIMIZE THE PRODUCTION OF CHLORINATED BY-PRODUCTS. MEET WITH THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK TO REVIEW THE REPORT INFORMATION.

Elements of Work

(a) It is not the purpose of this study to provide a detailed implementation scheme for plant rehabilitation. It is, however, necessary to scope the feasible short and long-term process modifications required to achieve optimum disinfection and contaminant removals.

Prepare a list of modifications which should be considered for detailed implementation evaluation. Provide an estimated cost for each of the proposed modifications.

(b) Prepare a schedule for the list of modifications.

(c) Meet with the Project Committee at the plant site to review the proposed modifications.

7. PREPARE 7 COPIES OF THE DRAFT REPORT AND SUBMIT TO THE PROJECT COMMITTEE.

Elements of Work

(a) The report must include all the information reported previously in the study. The information must be organized and presented in a logical and co-ordinated fashion.

A general table of contents will be provided for organizing the material in a manner consistent with other plant reports.

(b) Submit the draft report to the Project Committee for review.

(c) Prepare a separate letter report containing a recommendation(s) concerning the need for additional field testing to cover water quality conditions not available during the period of this study. The Project Committee may decide to delay completion of the final report until field data can be obtained to confirm the predictions of performance for the worst case water conditions.

8. REVIEW THE PROJECT COMMITTEE'S COMMENTS AND PREPARE 25 COPIES OF THE FINAL REPORT.

Elements of Work

(a) Conduct additional field testing if required. Discuss the implications of the results with the Project Committee if the results differ from the predicted performance.

(b) Amend the report as per review comments, incorporating additional field data if required.

(c) Submit copies of the final reports to the MOE for distribution.